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POWER

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Publishing Director

Volume 69 New York, May 21, 1929 *Number 21*

The Meddler

YOU know him, the officious busybody who is always butting into things with which he has no concern and forcing his advice and participation where they are not wanted.

You are doing something that you feel entirely qualified to do, in a way that you have carefully thought out or practiced before, and the meddler, who has never done anything of the kind and knows nothing about it, comes around to tell you how foolish you are to do it your way.

If you have the patience to show him why his suggestion is impracticable, he will either argue for it or dig up another just as bad. Anything to assert his assumption of superior wisdom.

He putters around the place, nosing into other people's affairs and stirring up discontent and irritation among the force.

One ought to get more pay, another ought not be obliged to do so and so. The conditions as to this and that are all wrong.

And there is the meddler with apparatus. He is continually taking something apart, perhaps a complicated machine or appliance that has been carefully set and adjusted by the maker and needs only to be let alone.

I do not mean to decry a wish to know the innermost working of things or to discourage periodic inspection of and attention to details, but one does not take his watch apart to know how it is built or to preclude the possibility of its making him late some day.

Neither do I wish to discourage legitimate and intelligent suggestions as to the betterment of conditions and methods. The men who live among and practice these are often in a better position than anybody else to see how they could be improved.

The power-plant engineer or superintendent is particularly well situated to indicate improvements not only in his department, but in the application of its products. Such suggestions, tactfully made, are quite different from the obtrusive directions of the meddler to whom nothing is right that he did not originate.

F. R. Low

POWER *Stands for . . .*

1. **Making Power When It Should Be Made**
2. **Buying Power When It Should Be Bought**
3. **Cheaper Power Through Modern Equipment**
4. **Easier Financing of Equipment Purchases**
5. **Better Use of Byproduct Heat and Power**
6. **Operating Methods That Save Money**
7. **Less Waste in Transmission and Application**

Higher Steam Temperatures

FOR several years it has been agreed that 750 degrees F. or thereabout is the practical safe limit of steam temperature for commercial power stations. This, of course, is with materials now available for construction of equipment exposed to the maximum steam temperature. But this limit, apparently determined by materials only, is in fact dependent largely on another factor—temperature variation.

There is an old story about a man who was drowned in a river the "average" depth of which was only six inches. In the same way equipment may be ruined or have its life shortened by steam whose average temperature is 750 degrees or even less if inadequate control of superheat allows the temperature to fluctuate widely from the mean. The existing 750-degree limit must be looked upon as a limit of the average, which may be increased somewhat as the range of fluctuations is reduced.

Various devices, such as proper combinations of radiant and convection superheaters, intelligent location of superheater surface, the use of desuperheaters to remove excess temperature, etc., promise reduction in these fluctuations and with it a permissible increase in average operating temperature even before the commercial development of more resistant materials that will safely permit even higher temperatures.

Decentralization of Industry Will Affect the Power Field

DURING the last thirty years there was noticeable in American industry a great concentration in definite manufacturing centers. Akron became a city of huge rubber factories. Detroit grew enormously through the location of automotive works within its bounds. More and more plants were added to the aggregation that already made Pittsburgh the world's greatest steel city.

Several years ago, however, a new tendency appeared that began to counteract this centripetal growth. Henry Ford's plan for the decentralization of the industries he controls was the first sign of this to receive general notice. This movement has increased until now the rural districts are definitely growing in favor at the expense of urban centers, so far as the choice of sites for new industrial plants is concerned.

This decentralization is bound to have a marked effect upon the methods of supplying power to industry. Located in a metropolitan area, where good utility service is available at reasonable prices, the manufacturer naturally was inclined to get his electricity supply from that source and to install complete power plants only when these were essential for his process work and he could take full advantage of byproduct power generation.

But when large industrial plants are located in rural districts, the case is greatly different. Considerations of availability, reliability and price frequently influence the owners to develop their own electric power, particularly in parts of the country where there is a considerable building heating load. As a result there is an increase in the number of private plants being built. If this tendency continues to grow, as it seems likely that it will, it promises increased opportunity for both power engineers and equipment manufacturers.

Selling Power Where It Should Be Sold

"IN SELECTING salesmen consideration should be given to their honesty, dependability and forcefulness. They should avoid the use of high-pressure methods and should develop the use of proper load-building methods, which will result in an ultimate satisfaction to the user and the company alike." This quotation is from a recently issued report of the Industrial Relations Committee of the N.E.L.A., which deals with the training of utility employees for effective and sound contact with the public.

The quoted advice is evidently intended to apply to the men, among others, who promote the sale of power in competition with the private plant. Theirs on the whole is a legitimate business activity that has built up a very substantial industrial load and has, at the same time, served thousands of industrial prospects not properly situated for the economical generation of power. Even good things do not sell themselves. It generally takes a little salesmanship to make the owner of such plants take the obvious step to serve their own best interests.

But sales skill, developed on legitimate projects, is sometimes hard to restrain, particularly when the salesman is faced with quotas and competitions for the greatest amount of new business. If left to his own devices or encouraged merely to "get the business," the salesman of industrial power is likely to seek loads that mean loss to the customer and little real profit to the utility. The competition of private plants has in many cases cut certain industrial power rates to the bone—in some cases, it would seem, below the profit margin. When the opportunities for byproduct power generation or other

conditions make even these low rates uninviting to the customer, the salesman may yield to the temptation to clothe specious arguments in the verbiage of sound engineering and economics.

One case is on record where a consulting engineer's report, passed without question by the power company and the prospective customer, subtracted from the cost of purchased power the saving obtainable by *not* operating an engine and compared this "net" cost with the total cost of locally made power, including the cost of operating the engine. Subjected to this fictitious double load, the private plant collapsed and went out of business. Such extreme examples of arithmetical juggling are fortunately rare, but there have been many cases where all debatable charges have been pulled in one direction as far as credulity would permit.

Fortunately, many light and power companies realize that such tactics are neither good ethics nor, in the long run, good business. They have adopted the policy of never recommending purchase except where it is definitely in the customer's interest. Such a policy, consistently adhered to, builds a permanent satisfied clientele and reduces selling cost and sales resistance in the case of the legitimate customer. A certain amount of low-profit business is given up in return for a solid background of that public good will which is a priceless asset to any public utility.

Revising Water-Power Resources Upward

MANY estimates have been made of the available water power in this country. Probably most of these have been low, since revisions of the figures have been upward. An interesting example of how the estimated figures for available water power may increase is found in the survey and report made by the U. S. Engineer Corps of the Tennessee River. This is probably the most comprehensive survey and report ever made of any river system. It comprises a co-ordinated plan of development for the entire Tennessee River system and includes one hundred and forty-one separate power projects.

If all the projects prove commercially feasible of development, they will require an installation of about six and one-half million horsepower of waterwheels and will produce twenty-two and one-half billion kilowatt-hours per year. The waterwheel capacity required for the full development of the Tennessee River and its tributaries exceeds the estimate of the water power in the ten Southern States east of the Mississippi River, based on the flow available fifty per cent of the time. It also exceeds the total capacity now installed in central stations, both steam and hydro, in these states. The estimated energy that can be generated by these water powers is about double that produced by central stations last year, in the states mentioned.

To make this a dependable source of power would require installing only about twenty per cent steam capacity. With the combination steam and hydro system the energy output would be increased to nearly twenty-six billion kilowatt-hours. One of the favorable features of the development of this river is that the conversion of secondary power into primary can be accomplished more cheaply by storage than by auxiliary power. The large storage facilities are capable of supplying water to produce about one-third of the total power estimated for the combined steam and hydro system. This estimate of the power is large and is beyond any previous calculation, according to the report.

A large part of this power pool lies within the State of Tennessee, but while large developments have been made in adjoining states, waterpower development in Tennessee has lagged. With the existing keen competition between steam and water power, a one-mill tax per kilowatt-hour produced by water, such as is exacted in Tennessee, is not the way to encourage its development. The industries that come with power development are generally a greater source of government revenue than can ever be expected from power. By extraordinary taxes on water power it is possible to prevent both power and industrial development and lose the advantages of both.

Why Put the Steam Loop in the Museum?

SEVERAL agencies are searching the country for relics; some are satisfied to obtain an antique chair or an antimacassar; others center their attention on old-time machinery.

The pictorial history of power-plant engineering reveals a most interesting evolution in which machinery one time popular has been replaced by machines operating on entirely different principles. Quite properly, a power museum should include the haystack boiler, the walking-beam engine and the crosshead pump, for these are ancient and have been eliminated by reason of their inability to meet modern conditions.

But the steam loop, more generally spoken of as the Holly loop, while hoary with age, is just as able to cope with present plant conditions as the latest device off the engineer's drawing board. True, it is not so often installed as its merits justifies, but probably this is due to the contempt of the modernistic power-plant designer for anything bearing a birth certificate issued before the beginning of this century.

In hundreds of factories high-pressure steam is fed to kettles and rolls, with the condensate being trapped to an open feed-water heater. The loss due to the flashing of part of the condensate into steam to meet the lower temperature condition, is large. In one plant this loss amounted to fifteen per cent of the coal bill. In such circumstances a steam loop could be arranged to receive the condensate at high pressure and release it to the boiler without this flashing loss.

The steam loop is too valuable a device to be placed on the museum shelf. It should be put to work.

Courtesy Westinghouse Lamp Company

Heating and Ventilating Services in the New Atlantic City Convention Hall

By D. D. Eames

Engineer, Lockwood Greene Engineers, Inc.

"A PERMANENT monument conceived as a tribute to the ideals of Atlantic City. Built by its Citizens and dedicated to recreation, social progress and industrial achievements."

This is the inscription on the new Atlantic City Convention Hall, which is to be dedicated on May 31, just before the opening sessions of the annual N.E.L.A. convention. This new hall is of interest not only because of its size, usefulness and architecture, but also for the heating, ventilating and other services that have been included in its design.

The structure occupies the block bounded by the famous Boardwalk on the front, by Pacific Avenue on the rear, and by Mississippi and Georgia Avenues on the north and south respectively. The width between the avenues is 350 ft. and the length on Mississippi Avenue, 678 ft. The ground area of the building is about 5¼ acres, or nearly equal to the area of the Capitol in Washington, including both the central structure and the House and Senate wings.

The Convention Hall is divided into two principal parts, the main auditorium and the ballroom. A spacious arcade with stores and shops forms the main entrance from the Boardwalk. On the ground floor below the auditorium is a large exhibition and garage space and at the front of the building are bathhouses for men and women communicating directly to the beach through tunnels under the Boardwalk. In the upper part, along the sides, there are about twenty large offices and committee rooms and a total of 33 stores along the street levels of the Boardwalk and Pacific Avenue ends.

The ballroom occupies the entire Boardwalk end of the building on the upper floor. It is a magnificent room 180 ft. long, 128 ft. wide and 54 ft. high, with stage and balcony. A loggia opens off the front of the ballroom with commanding views of the beach and ocean.

The auditorium is the main feature of the building. It is a room 490 ft. long, 350 ft. wide and 130 ft. high without columns or any obstruction across its length and breadth. It has a seating capacity of nearly 40,000 people in balcony and floor. The entire population of cities like Auburn, N. Y., or Williamsport, Pa., could be seated in this room with two or three thousand seats left over. The stage at the Pacific Avenue end is 165 ft. wide, by 85 ft. deep, with a proscenium opening 110 ft. wide and 50 ft. high.

The exhibition space below the main auditorium is about the same size as the room above, but of course with lower ceiling height. This floor is on the ground and may be used for heavy exhibits and at other times as garage and automobile parking space.

Heating and Ventilating Systems

The heating and ventilating of the building, particularly the ventilating of the main auditorium, furnished a problem of unprecedented size. This is indicated by the

number and capacity of the fans, namely, 106 fans supplying 746,000 cu.ft. per min. of fresh air and exhausting 1,140,000 cu.ft. vitiated air. All the fresh air is heated by indirect heaters having an aggregate surface of about 44,000 sq.ft. In addition to the indirect heaters there are sixteen window-type unit heaters and ventilators for entrance vestibules and a total of about 20,000 sq.ft. of direct radiation.

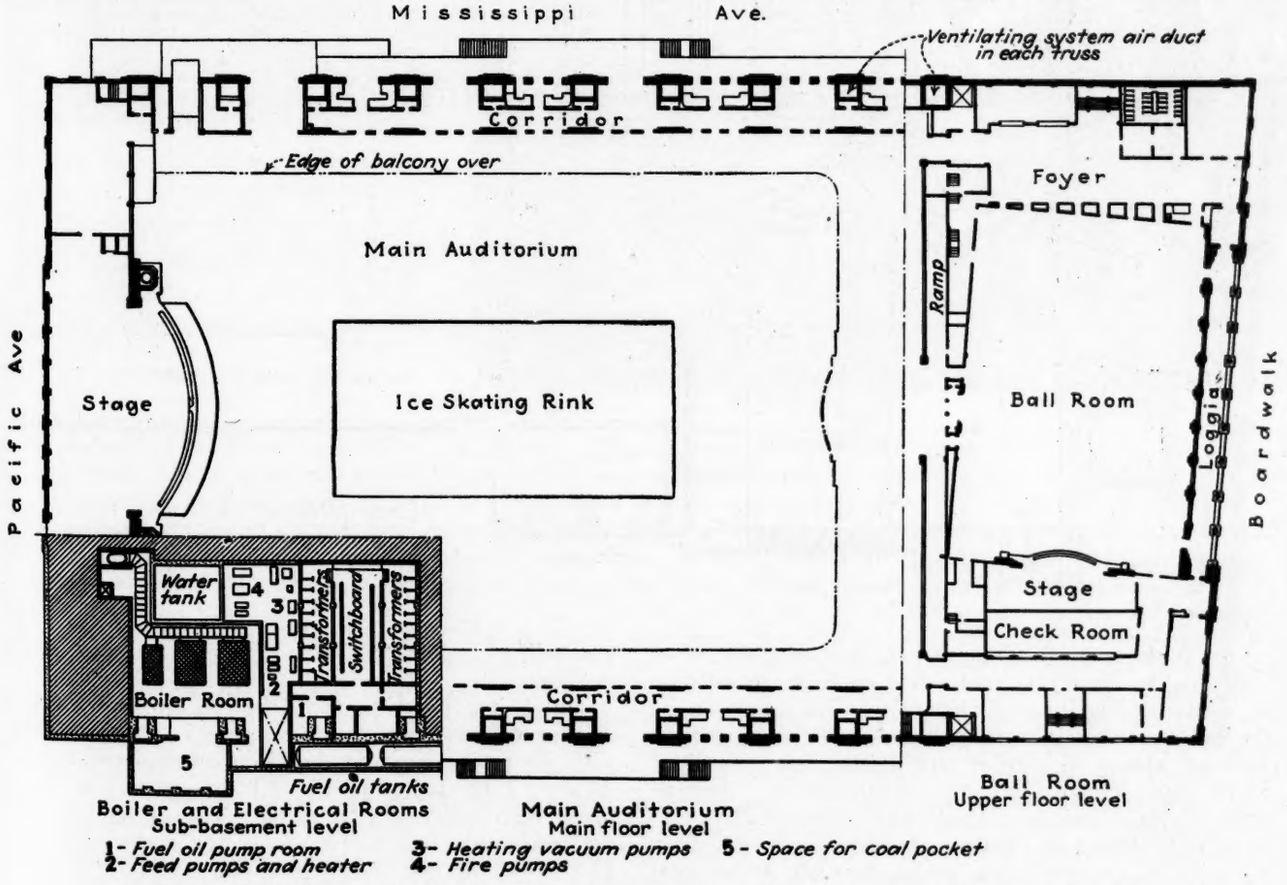
The ventilation of the auditorium was designed on the basis of upward air movement. In order to understand the arrangement of the apparatus to accomplish this circulation, some features of the design of the building should be known. The roof of the auditorium is supported on ten double trusses spaced on 49-ft. centers, each truss consisting of two members on 8-ft. centers. These trusses are in the form of three-hinged arches spanning 350 ft. and weighing 220 tons to each pair. The trusses rise vertically for about 70 ft. before curving toward the center of the building. At this elevation space was available for fanrooms where the main supply and exhaust fans are located. There is, accordingly, at each truss on both sides of the building, 70 ft. above the street, a double fanroom, one part containing a fresh-air fan and heater, and the other an exhaust fan. The fresh air supply is drawn through circular openings in the outside wall about 75 ft. above the street, passes through the indirect heater and into the fan. The fan stands directly over the space between the truss members and discharges vertically downward, utilizing the space in the truss as a duct. At the level of the balcony floor the truss is baffled off and the air diverted into ducts terminating in grilles along the edge of the balcony and along the side wall of the auditorium below the balcony.

The supply fans, sixteen in number, are 31,000-c.f.m. capacity, double-width, double-inlet, silent-vane type, operating at 382 r.p.m. with 10-hp. variable-speed remote-control motors and texrope drives.

The exhaust fans in the other part of the truss fanroom draw the air from the truss space above the fanroom level. In the sides of the beams formed by the trusses are openings, part of which are used for lighting apparatus and the remainder for inlets from the auditorium to the exhaust duct. The exhaust fans, eighteen in number, are 40,000-c.f.m. capacity double-width, double-inlet, multivane type, operating at 162 r.p.m. with 7½-hp. variable-speed remote-control motors and texrope drives. The exhaust fans discharge through penthouses on the roof behind a parapet wall. In addition to the main exhaust fans there are two 5,000-ft. propeller fans at the peak of each truss exhausting directly from the top of the room. These fans have constant-speed remote-control motors and are considered an important feature in the proper ventilation of the auditorium, particularly for the summer time. Recirculating arrangements are provided for the fresh-air fans, so that ordinary heating operations will be on an economical basis.

These main auditorium supply and vent fans, as briefly described, constitute the major part of the heating and ventilating equipment. The photographs of the building show several of the features referred to, and the drawings, particularly the sectional view, show the fans and duct systems.

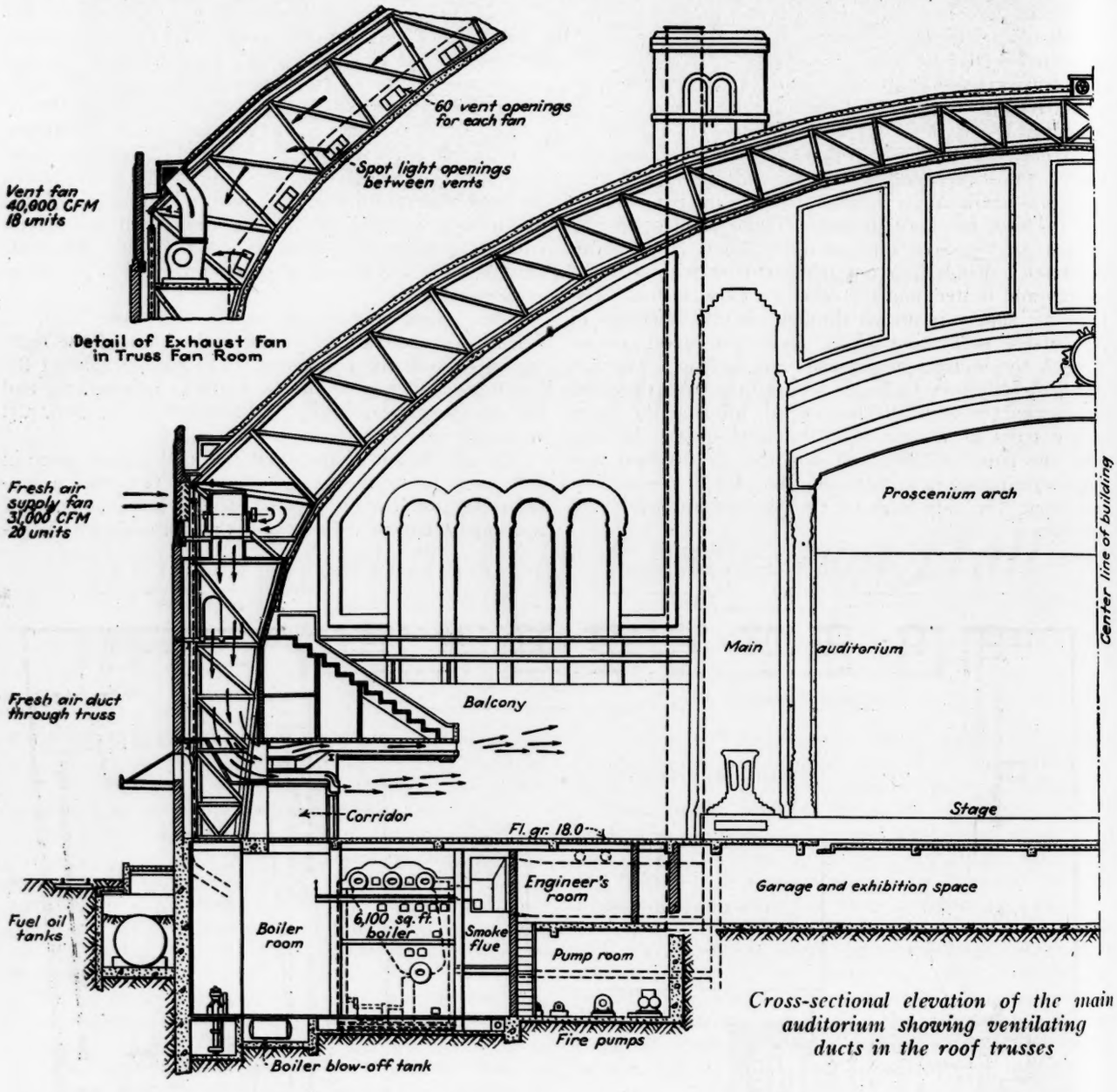
The ventilation of the exhibition and garage space in first story below the main auditorium, presented a considerable problem on account of the large amount of automobile engine exhaust and the relatively low head-



Plan of the new convention hall showing arrangement of boilers and pumping equipment

room. The data obtained during experiments for the Holland Tunnel were used as the basis for determining suitable quantities of air supply and exhaust. The fan-rooms are adjacent to the outside walls. There are two fresh-air supply fans with heaters, each fan being 40,000-c.f.m. capacity, multivane type, double inlet, double width, 206 r.p.m. with 15-hp. variable-speed motor. These two fans are on opposite sides of the room, draw their air from above the marquise, and discharge into transverse ceiling ducts connecting in the

The ballroom supply fans are three in number, located in the space above the loggia and discharging into the room through grilles along the edge of the balcony, in the columns along the loggia side, and under the stage. One of these fans is 25,000-c.f.m. capacity and the others 28,500-c.f.m. each. There are five exhaust fans each of 15,000-c.f.m. capacity exhausting through fifty small arched openings around the upper part of the room, these openings being provided with remote-controlled pneumatic dampers. In addition there is installed in



Cross-sectional elevation of the main auditorium showing ventilating ducts in the roof trusses

center of the room to a longitudinal duct which is 40 ft. wide by 2 ft. deep. It could not be made deeper because of restricted headroom. Outlets into the room are in the bottom of this duct at regular intervals. The exhaust fans are eleven in number, six in the fanrooms along Mississippi Avenue and five along Georgia Avenue. Each of these fans is a single-inlet single-width multivane of 12,000-c.f.m. capacity, drawing air directly from the side of the exhibition room, through grilles near the floor.

the ballroom about 2,700 sq.ft. of concealed direct radiation.

The boiler plant is near the Pacific and Georgia Avenue corner, occupying a depressed section of floor, with the pumproom and the electrical equipment room. Atlantic City datum is El. 0.0 for mean low water. Mean high water is El. +4.83. The ground floor of the convention hall is El. +2.0, the auditorium floor El. +18.0 and the boiler room El. —15.0. The boiler room extends up through the ground floor to the

auditorium floor level, thus having a total height of 33 ft. The excavation for the boiler room was protected and kept dry by a well-point system. All concrete below high-water level has been waterproofed, and great precautions taken to prevent any puncturing of the membrane by equipment supports or anchors. Under the boilers the waterproofing is protected against the heat of the furnaces by a hollow-tile floor construction, through which air will circulate.

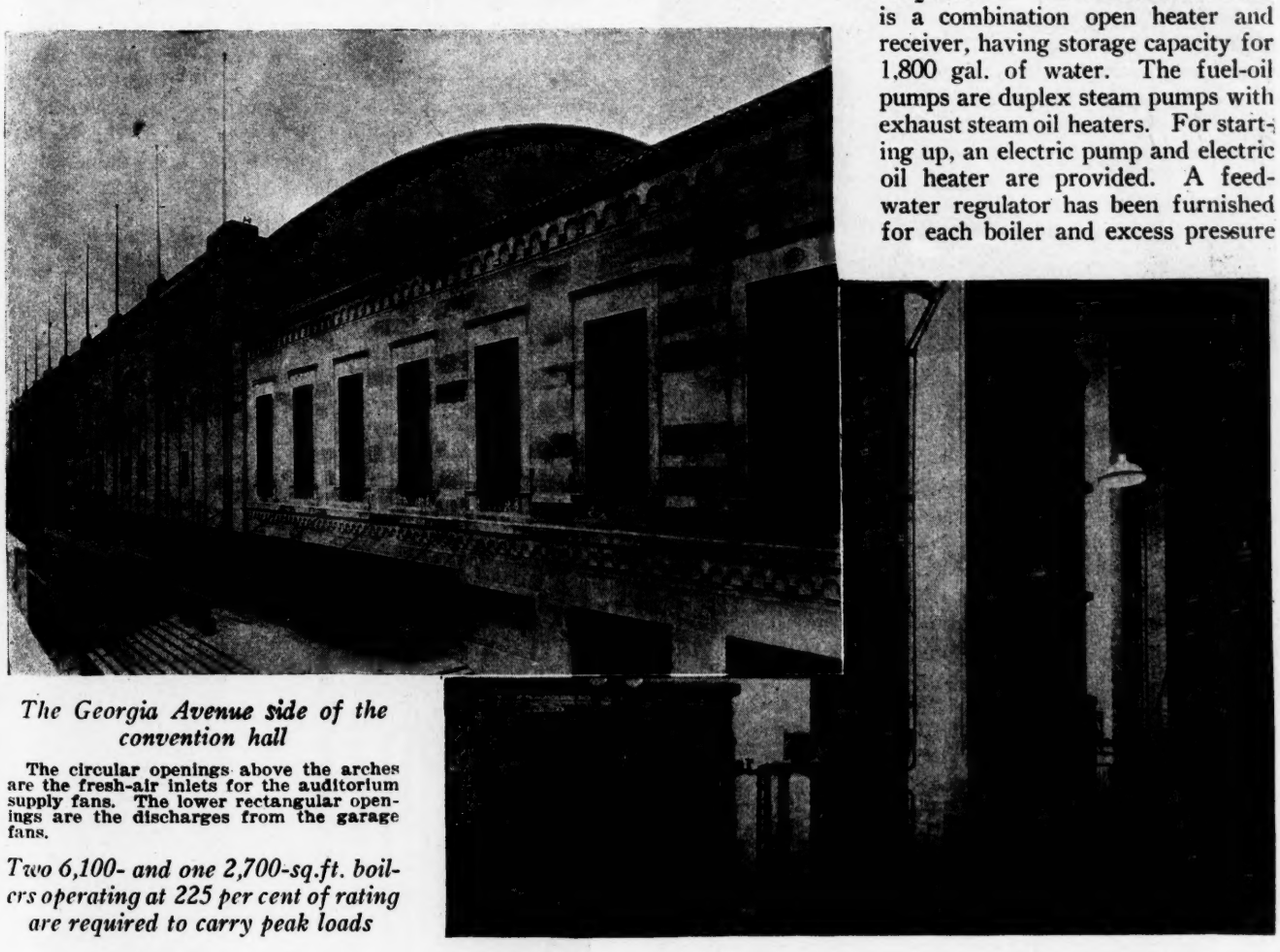
The anticipated maximum load on the boiler plant is about 120,000 lb. of steam per hour. This load will occur only a few times a year, and it is planned to carry it as a high overload on the boilers, thus conserving investment for boilers and boiler equipment. Three water-tube boilers have been installed, one of 2,700 sq.ft. size and two of 6,100 sq.ft. each. The small boiler is intended to carry the summer load, providing steam for heating water and other building services. All three boilers at about 225 per cent of rating will carry the winter peak.

Fuel oil is received in tank cars and unloaded by gravity into the storage tanks buried under a platform on the Georgia Avenue side. An excavation has also been made for coal storage in case oil should at any time cease to be available. Oil was chosen as fuel for this building after thorough consideration of its relative costs and advantages as compared to small-size anthracite, which is the usual fuel in Atlantic City. It was found that an oil-burning plant could be installed for considerably less money than a complete coal-burning plant, whereas the cost of oil would be somewhat greater than the cost of the equivalent amount of coal. The superior cleanliness, freedom from coal and ash dust in and around the building and the operating convenience of oil were considered sufficient to offset this extra operating cost and warrant the use of oil. As it has turned out, the cost of oil is much less now than when the investigation was made, so that oil with its other advantages is not costing any more than coal.

The oil burners are steam-atomizing type, two burners for the small boiler and six for each large boiler. They have full automatic control for oil, steam and air flow.

The boilers operate at 100 lb. pressure. Feed pumps are duplex, piston pattern, two are 12x8x12 in. and one is 7½x5x6 in. The feed-water heater is a combination open heater and receiver, having storage capacity for 1,800 gal. of water. The fuel-oil pumps are duplex steam pumps with exhaust steam oil heaters. For starting up, an electric pump and electric oil heater are provided. A feed-water regulator has been furnished for each boiler and excess pressure governors for each feed pump. Instruments include fuel-oil meters, recording and integrating flow meters, two-point draft gages and feed-water thermometer.

The steam distribution from the boiler room to the building is accomplished by an 8-in. high-pressure steam loop, making the circuit of the entire first story. Each indirect heater for the auditorium has a steam supply connection to this loop, with reducing valve at the heater for 15 lb. pressure. The unit heater and direct radiator systems are divided into three main groups, each with its reducing valves and low-pressure mains. Returns are collected in three pumprooms located as nearly central as possible to the group of radiators served. Each pumproom contains two motor-driven vacuum pumps and two condensation return pumps. The vacuum pumps discharge into the receivers of the return pumps, which are vented, and these discharge back to the feed-water heater at the boiler room.



The Georgia Avenue side of the convention hall

The circular openings above the arches are the fresh-air inlets for the auditorium supply fans. The lower rectangular openings are the discharges from the garage fans.

Two 6,100- and one 2,700-sq.ft. boilers operating at 225 per cent of rating are required to carry peak loads

A complete system of temperature control has been provided applying to both the direct and indirect heating systems. The method for controlling the main auditorium temperature and preventing alternate blasts of cold and warm air from the fresh air fans is as follows: Eight compound thermostats are provided, two on each side wall, two under the musicians' balcony and

The auditorium during construction

one at each side of the stage. These thermostats control individual and in some cases groups of heaters. In addition to the room thermostats there are provided two-point intermediate pilot duct thermostats acting on the diaphragm valves of the fan heaters. During the warming-up period the room thermostats are in control and the duct thermostats inactive. When the hall reaches the desired temperature, the room thermostats act to close the diaphragm valves on the heaters. The control is then automatically referred to the duct thermostats, which, by controlling the diaphragm valves, prevent the air from dropping below a predetermined temperature.

Control of the heating and ventilating systems is centralized at two points: First, the engineers' room adjacent to the boiler room, controlling the auditorium, garage and other apparatus in this end of the building, and second, the utility room near the Boardwalk end, controlling the ballroom and front portion of the building. The remote-control switches on supply and exhaust fans and the pneumatically controlled dampers are centralized in these rooms. An electrically operated temperature indicating system enables the operator to determine instantly and at any time the temperature at 117 locations within the building.

The fire-protection equipment consists of automatic sprinklers with hose stand pipes and roof nozzles. The primary water supply is the city water system and the secondary supply a 150,000-gal. reservoir adjacent to the pumproom and 12,000- and 20,000-gal. elevated sprinkler tanks in the Boardwalk and Pacific Avenue ends of the building.

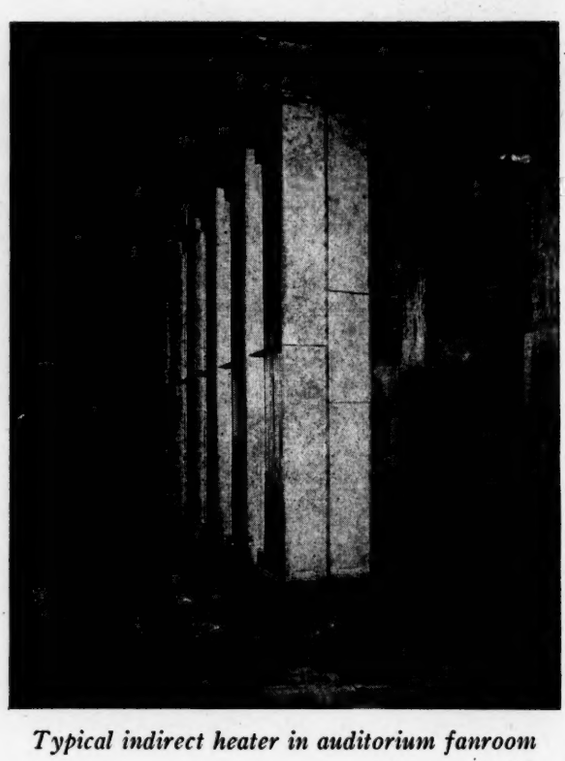
Automatic sprinklers are provided for the entire first floor, for all store basements, storerooms, auditorium and ballroom stages, proscenium arches and dressing and chorus rooms. The static pressure on the city water system is 40 lb., but the residual pressure is only 15 lb. Neither of these pressures is sufficient to supply water to the sprinklers in the higher parts of the building, consequently an automatic fire pump is necessary to make the primary supply available at these heads.

A cast-iron main, partly 8-in. and partly 10-in., was laid in the streets, forming a loop around three sides of the building, and connected to the city mains through check valves at three points. This loop will eventually be connected at the ends of Georgia and Mississippi Avenues to a 24-in. trunk main to be installed below the Boardwalk. All sprinkler risers and hose stand pipes connect to this fire protection main with a post indicator valve in each line.

Two 1,000-gal. underwriter pumps are in the pumproom near the boiler room and adjacent to the reservoir to which their suction pipes are connected. One is a motor-driven centrifugal unit and the other a duplex 18x10x12-in. reciprocating pump with an auxiliary $4\frac{1}{2}$x$2\frac{3}{4}$x4-in. pump, both with automatic governors. The auxiliary pump operates under control of its governor to maintain full pressure on the system up to the highest sprinklers. If a sprinkler head should open or any flow of water occur beyond the capacity of the auxiliary pump, the main pump would immediately start up and its 1,000-gal. per minute capacity would be available. The fire-pump supply reservoir is kept full by a 6-in. pipe with float valve direct from the city water mains.

The 20,000-gal. sprinkler tank in the Pacific Avenue end of the building is about 160 ft. above the street, and check valves are provided so that this water is reserved for the sprinklers in this end of the building. The 12,000-gal. tank in one of the front towers is similarly reserved for the high sprinklers in that end.

The convention hall and its equipment were designed



Typical indirect heater in auditorium fanroom

by the architectural and engineering departments of Lockwood Greene & Co., Inc., Walter W. Cook, chief architect, and Alexander H. Nelson, of Atlantic City, associated engineer. Riggs, Distler & Company, of Baltimore, were contractors for the heating and ventilating systems.

The Chief Operating Engineer Has Full Charge of Power Services

This outline of duties is of a standard form and can be easily adapted to the needs of any particular plant

By WALTER N. POLAKOV*
Consulting Engineer, New York City

This and other instructions to be published in *Power* from time to time will set up standard management practice for the important jobs and functions involved in the operation of a power plant. The author has written these as a result of many years of experience. Power plant managers will find them valuable guides.

IN INDUSTRIAL power plants the chief operating engineer or chief power engineer generally has full charge of all matters pertaining to the generation and distribution of power, heat and light. As the power department, in such cases, is a service department to production, the chief engineer reports to and receives authority from the production manager or general superintendent.

Duties: The duties of the chief operating engineer consist of:

1. Securing all facts and information pertaining to generation and distribution of steam and power.
2. Instructing, training and encouraging employees of the power department in performing their functions with minimum loss of materials, time and effort.
3. The chief operating engineer has no fixed hours of work, exercising his supervision at all times, but his presence or absence should be always made known to the production manager.

Responsibility: He is responsible to the production manager for:

1. Continuous service to all departments.
2. Economy in power generation.
3. Discipline within power department.
4. Correctness of all reports, records, and costs relative to power department.

Authority: To perform the above duties and to be responsible for results he has authority to:

1. Select employees and dismiss all and any employees in the power department, subject to the approval of the proper authority.
2. Specify and prepare purchase requisitions for all supplies and materials used in the power department, subject to the approval of the purchasing agent.
3. Develop and install new methods not as yet standardized, subject to the approval of the production manager or consulting engineer.
4. Schedule maintenance work and assign duties and responsibilities to power department employees.

Assistance: In discharging his duties he is assisted by:

1. The watch engineers, who are in charge of plant operation and discipline in the absence of the chief engineer, and are directly responsible to him.
2. The steam and power despatcher, to whom the chief engineer delegates the duties of steam and power distribution, service to outside departments, studies of utilization and transmission and apportioning the charges to consuming departments.
3. The power-house clerk, timekeeper, substore attendant and other minor executives in the power plant.
4. He may request special assistance for specific purposes from the master mechanic and the production staff.

Co-operation: In all matters relating to either service to the departments using steam and power or to individuals of departments whose co-operation is essential for safe and economic operation of the power plant, such as the engineering department, machine shop, laboratory, etc., the chief engineer is expected to give and receive direct co-operation.

Exception is made in matters involving the policy of the concern or a change of established practice in other than the power department. In such matters he must secure authority from the consulting engineer and confer with production manager and mechanical superintendent.

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ANY ORIFICE CAN BE USED AS AN EMERGENCY FLOW METER. For example, a scrubber spray nozzle was made to serve as its own flow meter. An old pressure gage was attached ahead of the nozzle. Calibration was accomplished by measuring the time required to fill a bucket from the discharge at various readings of the gage. These points were plotted to get the calibration curve. With this method errors in the gage are of no importance as long as the reading of the gage for a given pressure does not vary. Similar methods of measurement have many applications in every-day engineering.

TYPES OF MOTORS *Used on Combustion Equipment*

By H. L. Smith
Industrial Engineering Department
General Electric Company

FOR THE FUEL-BURNING PROCESS *in a power plant motors are required to drive stokers, coal feeders, forced-draft and induced-draft fans, clinker grinders and coal-pulverizing equipment. These drives include many types of motors and combinations of motors. The selection of the best drive involves many problems, on account of the varying conditions of load, speed and operating conditions, which are considered in this article.*

WHEN boilers are operated at high ratings and when economizers and air preheaters are used, forced- and induced-draft fans are necessary to provide sufficient draft. Industrial plants do not generally contend with the same type of loads as do central stations, so that draft fans have not been used as extensively in the former as in the latter. As the amount of air required for efficient combustion depends upon the load, it is necessary to control the air supply to the boiler and the rate of removal of the products of combustion. This can be accomplished by varying the fan speed, by the use of a constant-speed fan with damper control, or by varying the fan speed with damper control.

Draft fans are among the largest users of auxiliary power, and their efficient operation therefore is important. Fig. 5 shows the comparative input to a forced-draft fan with different types of drive. These curves indicate that the lowest power consumption is obtained by regulating the fan speed. A direct-current motor gives the best over-all efficiency, then comes the alternating-current brush-shifting motor, followed by the wound-rotor induction motor with secondary control, all of which are more efficient than constant-speed operation with damper control.

These curves show the relative kilowatt input with various types of fan control on a fan requiring 100 hp. at full speed. At 50 per cent of the air volume a squirrel-cage motor with the ordinary type of damper control will require about 43 kw. input, whereas with a wound-rotor induction motor the kilowatt input is about 21½, and with a brush-shifting motor, about 13½ per cent.

A constant-speed motor with damper control gives the simplest arrangement and lowest first cost. However, it is inefficient at low boiler rating. It also has other limitations; for example, in pulverized fuel- and oil-fired furnaces it may be desirable to keep the stack damper nearly open so as to relieve pressure in case of a mild explosion.

The damper control mentioned here is one in which the air volume is controlled by an ordinary boiler damper. However, there has recently been developed a system of damper control called "Vane control." With this type the efficiency of a fan driven by a constant-speed squirrel-cage induction motor approaches that of a fan

BOILER-PLANT MOTOR APPLICATIONS

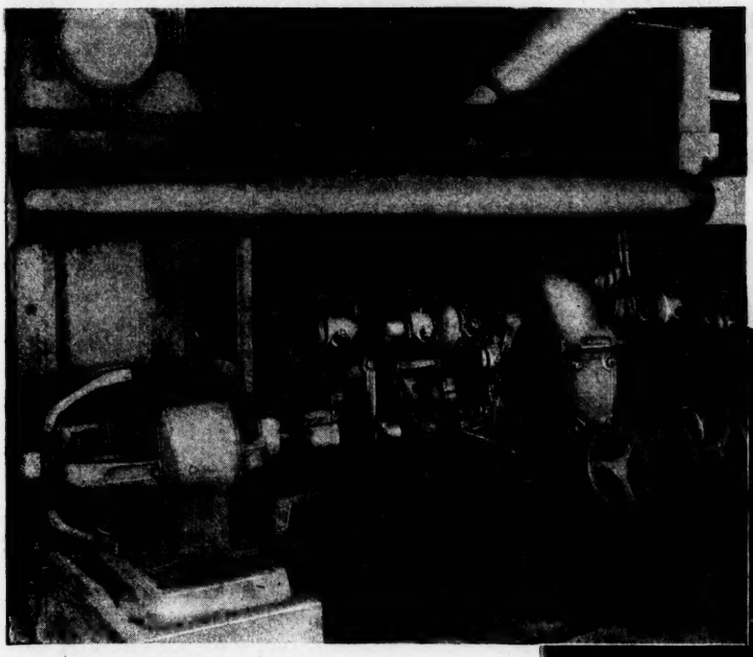


Fig. 1—Underfeed stoker driven by a 3-hp., 300- to 1,200-r.p.m. direct-current motor

Fig. 2—Coal-pulverizing mills gear driven by 150-hp. squirrel-cage induction motors

Fig. 3 (Above)—Traveling-grate stoker driven by a 10- to 2.5-hp., 1,760- to 440-r.p.m. shunt-characteristic adjustable-speed brush-shifting-type alternating-current motor

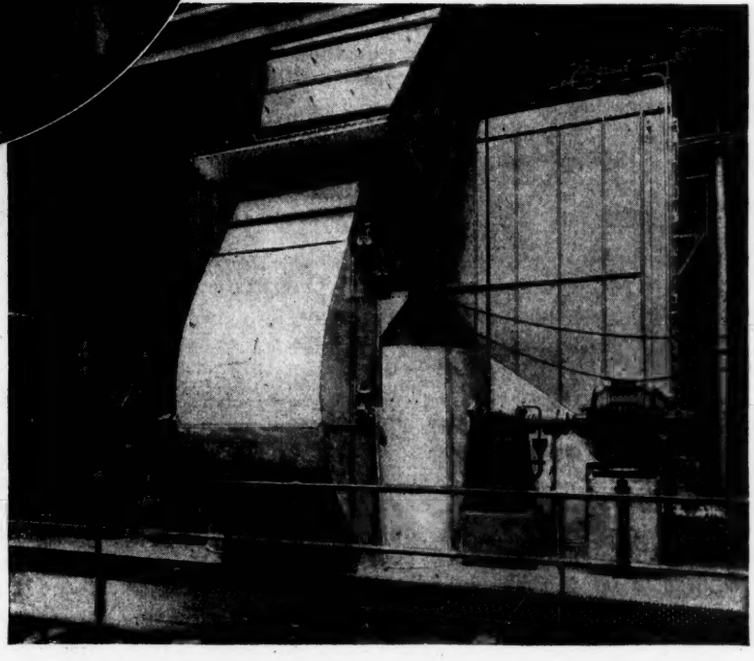


Fig. 4 (Right)—Induced-draft fan driven by a 100-hp. and a 225-hp. wound-rotor induction motor

on which the volume is controlled by changing the speed of a wound-rotor induction motor. This system of control may also be used with two-speed squirrel-cage induction motors.

The speed range of variable-speed motors, especially wound-rotor induction motors, is limited so that combined fan speed and damper regulation give the most desirable arrangement.

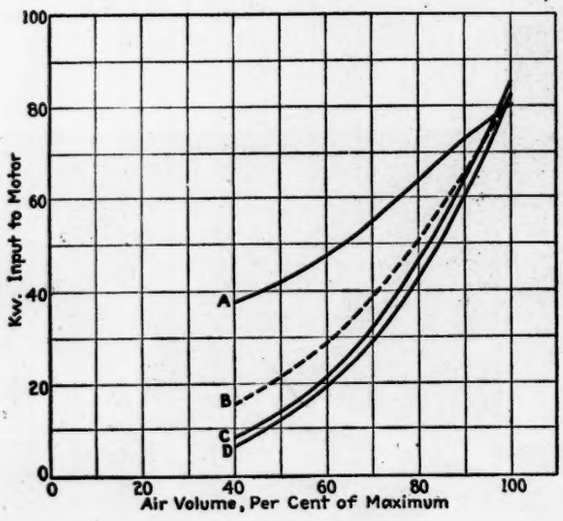


Fig. 5—Power-input curves for a forced-draft fan, requiring 100 hp. at full speed

Curve *A*, power required by squirrel-cage motor, air volume controlled by ordinary damper. Curve *B*, power input to slip-ring motor with rotor-resistance speed control. Curve *C*, power input to alternating-current commutator-type variable-speed motor. Curve *D*, power input to direct-current motor, speed adjusted by field control.

The types of drive most commonly used are:

A. Wound-rotor induction motors with secondary control.

B. Alternating-current brush-shifting motors

C. Direct-current motors with speed regulation by field control.

A number of other motor arrangements have been used, such as:

D. A two-speed, squirrel-cage induction motor, or two squirrel-cage induction motors of different speeds connected to the same fan.

E. A squirrel-cage and a wound-rotor induction motor of different speeds connected to the same fan.

F. Two wound-rotor induction motors of different speeds connected to the same fan.

Fig. 8 shows the saving in power at the low speed by the last arrangement over a single wound-rotor induction motor. Curve *AB* gives the input by using a single motor with secondary control. The input by using two motors, one 900 r.p.m. and the other 720 r.p.m., is shown by the curves *AC* and *DE*. Curves *AF* and *GH* show the input using two motors, one that can be operated at 900 r.p.m. and the other at 600 r.p.m. Curve *KL* shows the actual horsepower required to drive the fan, whereas the other three curves show the kilowatts input to the motor when delivering the horsepower as required by the fan. For example, at 50 per cent speed the fan requires 15 hp. to drive it. Under these conditions, if a 125-hp. 900-r.p.m. wound-rotor motor were used with the speed reduced by resistance control, the input would be 31 kw. If the driving motor at this time was the 75-hp. 720-r.p.m. machine, the input would be only 23 kw.; and if it were the 40-hp. 600-r.p.m. motor, the input would be only 17½ kilowatts.

If normal operating conditions require a speed slightly below 580 r.p.m., combination No. 3 is the best arrangement. With a normal operating condition requiring a speed slightly below 700 r.p.m., combination No. 2 is the best arrangement.

Direct-current motors with speed regulation by field control give good regulation with the highest efficiency at reduced speed. However, they are more expensive and direct current is seldom available for these units.

Draft-fan motors are exposed to a large amount of coal and ash dust, high ambient temperature and, in some cases, sulphur gases. It is necessary, therefore, to take special precautions with the insulation, especially on the rotors of wound-rotor induction motors.

The alternating-current brush-shifting motor has been used extensively for this service. This type of motor has high efficiency at reduced speeds; makes speed changes smoothly, it being possible to secure an infinite number of speeds; a wide speed range can be obtained, it being possible to secure a range of 3 to 1; and only a simple control is required. The low voltage that this motor has between commutator bars (2½ volts or less) allows it to be operated under bad dust conditions with little trouble due to insulation failure.

The main disadvantage of the brush-shifting alternating-current type motor is its relatively high cost. This increased cost is more than offset by the motor's advantages. The headpiece shows such a motor driving a forced-draft fan.

Stokers maintain the fuel bed with a relatively large amount of coal on the grates so that these drives may be shut down for a few minutes without seriously affecting operation. The speed range required varies from two to one to five to one.

Fig. 6—Wound-rotor motor, with inclosed slip rings outside the bearings, driving a coal pulverizing mill

The direct-current adjustable-speed, shunt-wound motor is best suited for this service. It can be readily secured to give four to one and, if necessary, five to one speed-range by field control. The motor's characteristics enable it to maintain practically constant speed

regardless of changes in load. It can develop a torque greater than that corresponding to full-load when operating at reduced speed. This is desirable on overfeed or underfeed stokers, where the torque at reduced speed is greater than at full speed. For example, on a motor with a four to one speed range, it is an easy matter to secure double full-load torque at one-fourth speed.

These motors are exposed to a great deal of dust and should preferably be totally inclosed or inclosed fan cooled. When open motors are used, they should be provided with top half solid covers.

For use on alternating current there are three types of motors available:

1. Constant-speed squirrel-cage induction motors with gear-changing device on the stoker or some form of variable-speed transmission.
2. Two-speed or multi-speed squirrel-cage induction motors.
3. Wound-rotor induction motors with secondary control.
4. Shunt characteristic alternating-current commutator motors.

Two-speed or multi-speed induction motors are largely used, especially where the boiler load is fairly constant or where frequent adjustments are not required. In certain cases a single-speed squirrel-cage induction motor can be used under these same conditions.

The arrangement using a constant-speed squirrel-cage induction motor with some form of variable-speed transmission has the advantage of using a simpler type of motor and will give operation comparable to that secured with the alternating-current commutator motor of shunt characteristics, as a large number of speeds can be secured and the change in speed with variations in load would be small.

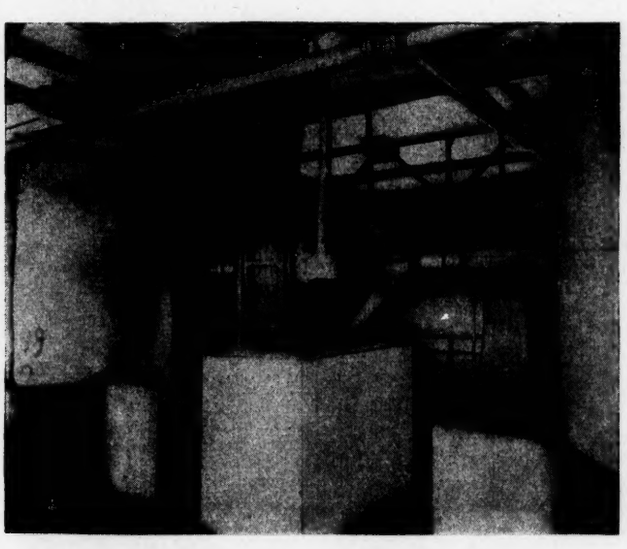


Fig. 7—Wound-rotor motor driving two induced-draft fans, one on each end of the motor shaft

The wound-rotor motor is suitable where the speed range does not exceed 2 to 1. A speed range greater than 2 to 1 is not recommended, as a wound-rotor induction motor with resistance in the secondary has a series characteristic that tends to become relatively flat at greatly reduced speeds. As the torque on an underfeed or overfeed stoker varies, this tends to cause variations in the stoker speed, with the possibility of stalling on a comparatively small overload. Approximately four to one speed range can be secured by the use of a two-speed, wound-rotor induction motor.

The shunt characteristic alternating-current commutator motor approaches most nearly, of any alternating-current motor, the characteristics of the

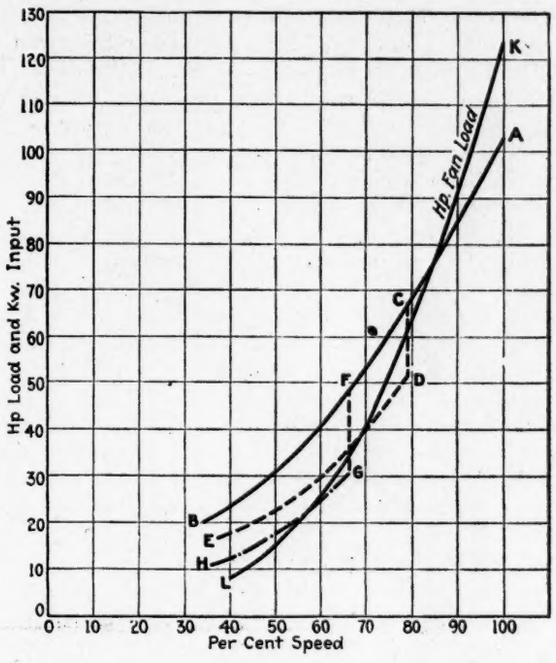


Fig. 8—Relation between the horsepower required to drive a fan and the kilowatts input to the motor

Curve *KL*, horsepower required to drive the fan at different speeds. Curve *AB*, kilowatt input to a 125-hp. 900-r.p.m. wound-rotor induction motor. Curve *DE*, kilowatt input to 75-hp. 720-r.p.m. wound-rotor induction motor. Curve *GH* kilowatt input to 40-hp. 600-r.p.m. wound-rotor induction motor.

adjustable-speed, shunt-wound direct-current motor. For the same reasons as mentioned for the direct-current motor, it makes the most suitable alternating-current motor for stoker drive. An infinite number of speeds can be secured, as the speed is changed by shifting the brushes about the commutator and the change in speed is gradual over the whole range. A speed range of three to one can readily be secured, while four to one is possible.

Only the secondary current is carried on the commutator and the voltage between comutator bars is low, less than two volts per bar. Open-type motors with a drip cover can be successfully used even though exposed to coal dust.

When selecting an alternating-current motor for stoker drive, especially for an overfeed or underfeed stoker, care must be taken to have sufficient horsepower at the low speed. Alternating-current motors have inherently constant torque, while many stokers require a torque at low speed greater than that at high speed, which means that the motor must be selected to take care of the torque at low speed.

Alternating-current motors of the low-voltage type are used and will thus permit using simple air-break contactors for the primary. Overload and undervoltage protection should be used on these units. For wound-rotor induction motors a drum controller is preferable for the secondary.

No secondary control is required on alternating-

current brush-shifting motors, as the speed regulation is secured by moving the brushes. This can be done mechanically by hand or by a pilot motor controlled from a push button or regulator.

For pulverized-coal fuel feeders the conditions are practically the same as for stokers, and the particular conditions in the plant should govern the decision as to whether open or inclosed motors should be used.

Squirrel-cage induction motors can be used for clinker-grinder drives. These motors are exposed to a considerable amount of abrasive ash dust and moisture and totally inclosed motors with special moisture-resisting insulation will give the best results.

Both squirrel-cage and wound-rotor induction motors are used for driving pulverizers. When squirrel-cage motors are used, starting torque is important as this drive may require as much as 200 per cent of the full-load torque for starting under load. These motors are exposed to a great deal of fine coal dust and, for this reason, squirrel-cage motors are preferable, but should be provided with special insulation for the dust conditions.

Where wound-rotor motors are used, either the fan-cooled or pipe-ventilated type is most suitable. The fan-cooled motor, essentially a totally inclosed motor with forced ventilation secured by a fan built in as part of the motor, is considerably more expensive than the open motor. The pipe-ventilated motor is not as expensive as the fan-cooled motor, but it is not always practicable to pipe a supply of clean air to the motor, and when the cost of this piping and installation is considered, the total cost may be as great as for a fan-cooled motor. The open construction motor with outside inclosed collectors and special dust-resisting insulation has proved successful.

Used in connection with the pulverizer is the equipment to convey the pulverized fuel. This may use screw feeders or fans, for either of which constant-speed motors are suitable. The use of constant-speed motors is recommended. For the feeders the motors may economically be inclosed, while open motors with special insulation for dust conditions are suitable for the blower. Where direct-current motors are used for any of this equipment, it is preferable that they be totally inclosed.

Full-voltage starting should be used where practicable. Control for the pulverizer mill, pulverizer exhauster and feeders should be so interlocked that the exhauster will always be in operation before the pulverizer and arranged so that the pulverizer will be shut down if the exhauster fails and, if the pulverizer is shut down, the feeders must shut down.

Make Live Circuits Safe Before Working on Them

By Marin Phillips

ACCIDENTS on electric circuits may be classified as fatal and others not so serious, such as burns and falls caused by getting a shock. It is possible to be badly burned by coming in contact with a live circuit or being near a flash caused by a short circuit.

When work has to be done on panel boxes, switches, busbars and similar equipment, the current should be shut off if possible, so that the work can be done safely without taking undue risks. There are times when the current cannot be shut off on account of the continued operation of the plant. This will make it necessary to work on the circuit when alive. In most cases this can be done in comparative safety if proper precautions are taken to guard against accidents that can happen due to a short circuit or the accidental grounding of a line.

Whenever the work consists of splicing or tapping a dead line to a live one, never fail to test the insulation resistance between wires and to ground. This will be necessary to guard against the possibility of attempting to splice on a line that is short-circuited or grounded. A Megger testing set or a magneto tester that will ring through 25,000-ohms resistance will be found satisfactory when such tests are made. When splices are to be made on live cable work, it is a safe precaution to cut the insulation away only where the tap is to be made and from one cable at a time. Splice on one wire and tape up the joint securely before cutting away the insulation on the other cable for the next splice.

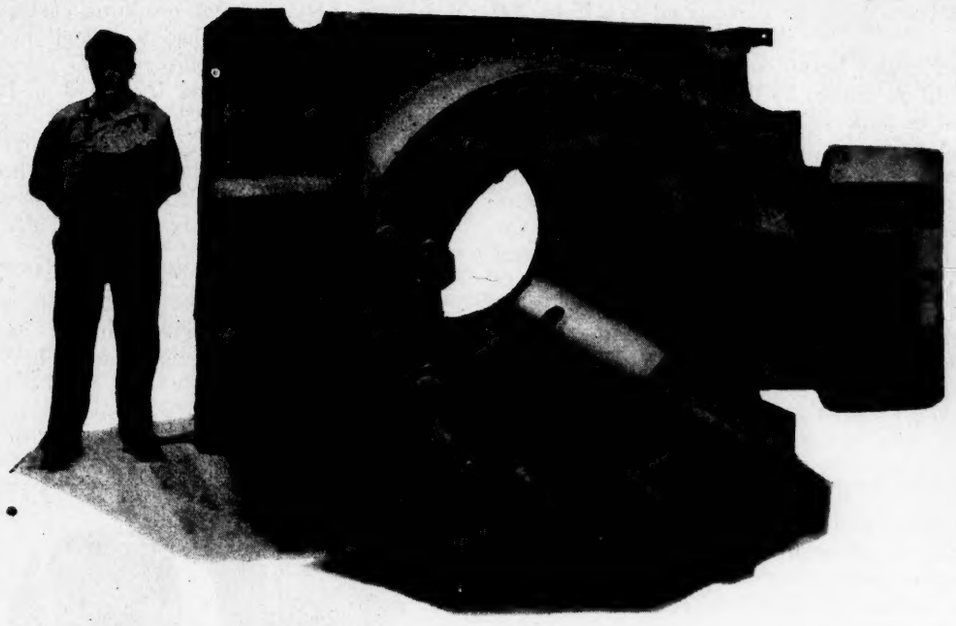
Making Circuit Tests

It is safe practice to use a short piece of ten-ampere fuse wire to make the connection between the live cable and the dead one. This will serve as a check against the test already made on the dead cables. In case there is a fault in the line that was not discovered in the first test, the small fuse wire will blow without doing any damage. On the other hand, the workman attempting to make the splice may be severely burned or be caused to fall and be seriously injured.

Sometimes the occasion arises where it is desirable to parallel a line of feeder cables or busbars with another in order that the load can be more evenly divided and distributed between the feeder lines. It is a general practice among workmen to rely wholly on a test lamp when phasing out the circuit in order to locate the corresponding cables so that they can be tapped together. Here is another place that a short-circuit can be caused that will do a lot of damage if safety precautions are not exercised. When making these parallel connections it is always advisable to make some form of a check on the lamp test. An easy and sure check test to make is to use a piece of small fuse wire, as previously mentioned. The lamp may have burned out or in some way failed to light, thereby causing an attempt to be made to parallel wires of opposite polarity, resulting in a short circuit. Then there is the danger of getting hold of the wrong cable when the attention is drawn away from the work while laying the test lamp aside.

If the work is to be undertaken on live busbars and switches, all the phases should be well protected with guards except the one that is being worked on. This protection is best accomplished by covering them securely with rubber blankets, empire cloth or fiber boards, or by constructing boxes out of dry boards, deep enough to cover the width of the busbars.

When work is being done on live busbars it is safer and better to work from underneath rather than above if possible. If anything should happen causing a flash, the arc and heat will travel upward, and is almost sure to catch the workman in the face, increasing the possibility of serious burns if he happens to be above the work. Another advantage of being underneath and reaching up to the work rather than sitting on it and reaching down is, in case of a shock or a flash, the workman will have a better chance to escape. On the other hand, if a workman gets hung up on the circuit and cannot let go, he will have a better chance of getting loose by falling and breaking the contact.



DIESEL RELIABILITY

Insured by

Correct Materials

By Charles H. Hughes

AS AN engineer walks through an engine room listening to the rhythmic sounds of the main units and the various auxiliaries, his thoughts often turn to the designer who chose the various materials and made the calculations for the strength of the different parts.

The designer's understanding of, and experience with, materials must be particularly broad when designing Diesel engines, for here high temperatures and pressures are encountered in a cycle of operations different from those of the reciprocating steam engine and steam turbine.

While the operating engineer cannot be expected to know all the intimate details of metallurgy, he should understand the reasons why certain metals are used for certain parts. Consequently, a brief recital of the tests made on the materials used in single- and double-acting Diesel engines from 1,500 to 3,000 hp. ordered by the Shipping Board should be of advantage.

In Fig. 1 appears a machine for making tensile tests. This particular machine, which is used in many metallurgical laboratories, is equipped with an autographic attachment and with a furnace so that specimens can be tested under high temperature conditions. A standard specimen or coupon used for tensile strength testing is always made 0.505 in. in diameter.

If a piece of metal is subjected to a stress or pull, it will stretch, but upon release of the stress the metal returns to its original length if the stress has not been too great. The elastic limit is the greatest stress a material will stand without a permanent deformation remaining after release of the stress. The reduction of area is obtained by comparing the area at the break with the original area, and the elongation by measuring the distance between the prick points, generally two inches apart, on the coupons before and after breaking.

Transverse tests of iron castings are made from "arbitration" bars 1¼ in. in diameter by 15 in. long. The bars are placed on supports 12 in. apart, the load being applied at the middle. For information on the grain structure microphotographs may be taken of the broken area.

To measure hardness most laboratories use a Brinell testing machine which has a hard steel ball 10 mm. in diameter that is pressed into a specimen made smooth on two opposite sides. The load on the ball is 3,000 kg. (6,614 lb.) for iron and steel, and 500 kg. for non-ferrous metals. The size of the indention in the specimen is referred to an arbitrary scale previously established, called the Brinell scale, and the readings from the scale are in terms of Brinell hardness. Readings of 200 for iron and steel are high, indicating a hard material for such parts as cast-iron cylinder liners, while babbitt metal for bearings may have a reading of only 20.

With a Shore scleroscope, the distance a plunger of known size, when dropped from given height, rebounds from the specimen, is indicated on an arbitrary scale.

Shore readings from 40 to 55 correspond to 235 to 260 Brinell.

Diesel engines under heavy continuous full-load duty and for vessels to be classed by the American Bureau of Shipping should be built to conform to the requirements of the American Bureau with regard to materials for the different engine parts.

When comparing the principle of operation of steam and Diesel engines, a marked difference in the means for obtaining reciprocating motion is noted. In the steam engine this is derived from the expansion of steam in alternate ends of the cylinder, while the explosion of a mixture of highly compressed oil and air is the motive power of the Diesel. The cylinders in both cases may be considered the heart of the engine, and consequently the greatest care must be used in the design, materials and workmanship.

Cylinder Head Material

For Diesel engines the cylinders, heads and liners are generally of cast iron, although cylinders have been made of chrome-vanadium steel. Tests of cylinders and heads of several large engines are shown in Table I.

In the cylinder heads are the valves set in cast-iron cages. The fuel and air prevent their respective valves from being subjected to the excessive heat experienced by the exhaust valves. The exhaust disk and valve stem gets the full heat of the exhaust gas, plus the pounding of the disk on its seat. The stem cannot be satisfactorily water cooled, with the result that a special heat-resisting alloy is required. Disks of nickel chromium or nichrome made up of 61.2 per cent nickel, 24.88 per cent iron, 12.05 per cent chromium and 1.44 per cent manganese, can stand high temperatures. Stems and disks of silcome, containing 95 per cent chromium, 3.5

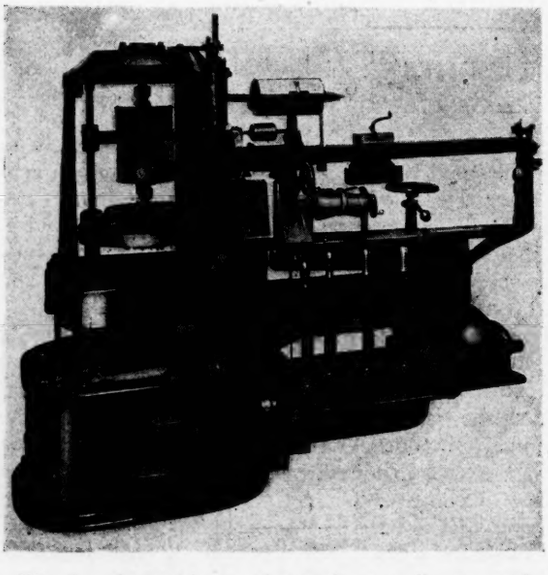


Fig. 1—A machine to determine tensile strength

per cent silicon and with a medium carbon content, will not scale at a temperature of 1,750 deg. F.

Cylinder liners are subjected to particularly hard usage, not only to high temperatures and pressures, but also to the wearing action of the piston rings. This calls for a grade of cast iron having a hard surface that will wear well at high temperatures. The iron should be fine-grained and have a high carbon content. For instance, iron with 2.86 per cent graphitic carbon and 0.77 per cent combined carbon had a Brinell hardness of 230, whereas one with a graphitic of 2.77 per cent and a combined carbon content of 0.72 had a Brinell of 167. Brinell hardness above 300 has been reached, but the usual hardness in large engines is around 200, and even at this figure many shops have experienced difficulty in machining their liners. Analyses of liners of a number of large Diesel engines are given in Table II.

Pistons and Piston Rings

Pistons are of cast steel or cast iron, with the tops in single-acting engines slightly smaller in diameter than the body to allow for expansion. They may be either

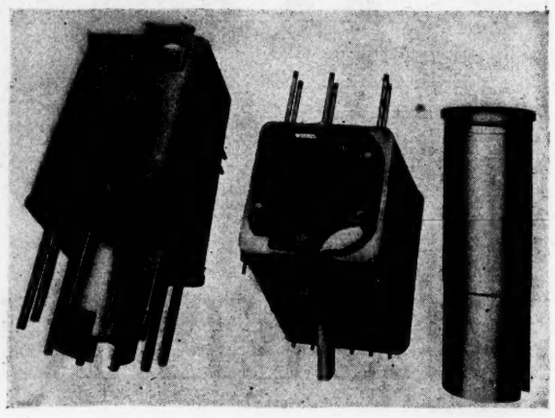


Fig. 2—A well designed cylinder and liner

water or oil cooled. Care must be taken in casting that the walls are the same thickness and that there will be no porous spots.

The piston rings working against the cylinder liners should be of iron having a slightly lower Brinell hardness than the liners. The rings should be hard in order to obtain the necessary springiness, but not too hard or they will cut the liners. The wear of the rings and liners depends largely upon the proper lubrication, with respect not only to the grade of oil, but also to the amount; often, too much oil is as harmful as too little.

Piston Rod Not Exposed in Single-Acting Engines

In single-acting engines the piston rod is not exposed to the explosion and is not subject to the high temperatures as in the double-acting engine. However, the greatest care must be exercised in the strength calculations and in the machining; when being installed, the rod must be correctly lined up. Furthermore, the lower fuel valves in double-acting engines should be located so that the maximum heat area does not come directly on the rod, which is hollow and is either oil or water cooled. There are different opinions among engine builders as to the grade of steel; specimens tested range in tensile strength from 70,000 to 113,000 lb. per sq.in., as given in Table V. As to hardness the chrome-nickel and chrome-vanadium rods in the table had a Brinell of 228, and the molybdenum of 190.

Vanadium does not appear to affect the endurance of plain carbon steel. Chromium-nickel steels resist acids and chromium copper steels resist oxidation at high temperatures.

Among the patented steels is one sold under the trade name "Rezistal." When forged, such a rod has a tensile strength of 113,000 lb., an elastic limit of 90,000 lb., an

elongation of 31.5 per cent, a reduction of area of 49 per cent and a Brinell of 228. All grades of Rezistal are highly resistant to oxidation and scaling.

Although some builders prefer special steels in connecting rods and crankshafts, the usual practice is to use a good grade of steel without chromium, vanadium or nickel. A high tensile strength with a low elastic limit is not desirable. Crankshafts should be of ample size and accurately machined.

Tierods for vertical Diesel engines extend from the cylinder tops to base, and serve to tie the cylinders to the base. Steel for these rods should have a high elastic limit; that is, it should stretch considerably before breaking. Typical tests are shown in Table VI.

Columns for vertical Diesel engines are of cast steel or cast iron with accurately finished guide faces. The base, or foundation, is of cast iron with the sections bolted together. A good grade should be used, one that is not brittle. The base should be ribbed where necessary and large fillets used at all corners.

Of course other materials have been and can be used with entire safety and satisfaction. However, the test data here given enable the buyer and seller of Diesel engines to be certain that the material used will give the expected service.

One surprising point to be noted is the wide range in tensile strength of the cylinder-head material. This ranged from 85,000 lb. for a chrome vanadium steel to 29,300 lb. for cast iron. Simultaneously, there is a wide variation in the piston rod and piston body material. In other details, such as connecting rods, crankshafts and tierods, there is greater uniformity, due, of course, to the fact that builders made use of materials that were similar from a metallurgical point of view.

Main bearings should be of ample diameter and length, the boxes being designed so they can be removed readily. The babbitt should be well secured in the boxes. The lower half can be lined with a harder grade than the upper. An excellent metal for a bottom bearing was made up of 4.6 per cent copper, 91.4 per cent tin, 3.4

TABLE I—TESTS ON CYLINDER AND HEADS

Part	Material	Strength, Lb. per Sq.In. Tensile	Strength, Lb. per Sq.In. Transverse	Elongation, Per Cent	Total Graphitic Carbon, Per Cent	Carbon Combined Carbon, Per Cent	Mn	P	S	Si
Cylinder	Cast iron	37,000	3,000	....	3.15	....	0.70	0.27	0.116	1.34
	Cast iron	33,200	3,500	....	2.86	0.77	0.64	0.20	0.11	1.25
	Chrome vanadium steel*	85,000	59,500 Elas.	27.2	....	0.23	0.75	0.024	0.038	0.20
Heads	Cast steel†	72,500	36,500 Elas.	28.0	....	0.24	0.64	0.013	0.021	0.39
	Cast steel‡	74,850	40,300 Elas.	30.0	....	0.25	0.72	0.039	0.033	0.35
	Cast iron	29,300	3,590	....	2.74	0.71	0.75	0.145	0.084	1.02
	Cast iron	36,750	4,050	....	2.65	0.47	0.60	0.44	0.11	2.00

*65 per cent reduction of area; 1.07 Cr; 0.10 Va. †43 per cent reduction of area. ‡49.5 per cent reduction of area.

TABLE II—TESTS OF CYLINDER LINERS

Specimen	Strength, Lb. per Sq.In. Tensile	Strength, Lb. per Sq.In. Transverse	Deflection, Per Cent	Brinell Hardness	Graphitic Carbon, Per Cent	Mn	P	S	Si	Ni	Va	Cr
A	23,000	3,730	0.08	185	2.54	0.96	0.19	0.09	0.83	0.69	0.06	0.35
B	36,000	4,200	0.27	212	2.60	0.57	0.53	0.08	1.10	0.30	....	0.72
C	39,450	4,260	0.102	217	3.06*	0.60	0.33	0.116	0.99	1.65	....	0.26
D	.....	.....	.....	198	2.37*	0.45	0.42	0.093	1.44	....	....	....

*Total carbon.
Mn = manganese; P = phosphorus; S = sulphur; Si = silicon; Ni = nickel; Va = vanadium; Cr = chromium.

TABLE III—TESTS OF PISTON MATERIAL

Specimen	Material	Tensile Strength	Transverse Strength	Elastic Limit	Elongation, Per Cent	Reduction of Area, Per Cent	C	Mn	P	S	Si
A	Cast steel	74,500	.....	35,500	29.0	44.5	0.27	0.68	0.044	0.037	0.36
B	Cast steel	70,500	.....	39,500	28.5	43.7	0.22	0.68	0.012	0.022	0.39
C	Cast steel	77,900	.....	44,610	30.0	56.9	0.28	0.67	0.03	0.028	0.36
D[1]	Cast iron	30,184	3,822	.....	....	....	....	....	....	....	....
E[2]	Cast iron	35,200	4,490	.....	....	....	....	....	0.26	0.096	....

[1]Graphitic carbon, 2.89; combined carbon, 0.60. [2]Total carbon, 3.1.

TABLE IV—PISTON-RING TESTS

	Strength, Lb. per Sq.In. Tensile	Strength, Lb. per Sq.In. Transverse	Deflection, Per Cent	Brinell Hardness	Graphitic Carbon	Combined Carbon	Mn	P	S	Si
A	19,000	3,060	0.118	173	2.86	0.64	0.51	0.46	0.115	1.97
B	20,900	3,450	0.127	167	2.77	.....	.....	.....	.....	.....
C	.....	.....	.....	200	2.97	0.35	0.40	0.30	0.12	1.70
D	.....	.....	.....	184	3.07	0.37	0.72	0.35	0.11	1.40

TABLE V—PISTON-ROD MATERIAL

Type of Engine	Test	Material of Rod	Tensile Strength	Elasticity	Elongation, Per Cent	Reduction of Area, Per Cent	C	Mn	P	S	Si	Cr	Va	Ni	Cu
Single-acting	A	Cast steel	69,000	33,300	33.0	56.8	0.18	0.87	0.056	0.04	0.41	....	....	....	....
	B	Steel forging	70,000	49,500	32.0	57.0	0.29	0.58	0.016	0.03	0.155	....	....	....	....
	C	Steel forging	75,000	43,000	33.0	51.0	0.35	0.48	0.02	0.027	0.14	....	....	....	....
Double-acting	D	Chrome-nickel	113,000	98,500	20.7	58.0	0.13	0.47	0.023	0.012	0.27	6.48	2.08	....	1.10
	E	Chrome-nickel	83,500	67,000	27.2	69.0	0.14	0.60	0.03	0.033	0.16	0.21	3.90	....	....
	F	Chrome-vanadium	115,000	92,000	22.5	64.0	0.28	0.50	0.014	0.028	0.14	0.86	0.17	....	....
	G	Chrome-molybdenum	96,500	67,000	28.0	63.5	0.36	0.64	0.027	0.021	0.25	0.78	Molybdenum	0.22	....

TABLE VI—TESTS ON TIERODS

Test	Part	Tensile Strength	Elasticity	Elongation, Per Cent	Reduction of Area, Per Cent	C	Mn	P	S	Si
A	Connectiong rod	70,000	37,000	30.0	45.0	0.32	0.51	0.014	0.028	0.11
B		73,000	38,000	30.5	47.2	0.40	0.58	0.012	0.028	0.148
C		74,000	44,000	25.5	43.5	0.33	0.67	0.017	0.032	0.15
D	Crankshaft	82,500*	41,000	25.0	44.0	0.42	0.59	0.028	0.04	0.27
E		69,000	37,500	26.5	40.0	0.28	0.47	0.027	0.038	0.22
F		73,000	41,000	27.5	48.0	0.31	0.65	0.03	0.044	0.22
G	Tierods	68,000	36,500	35.0	36.0	0.30	0.59	0.012	0.025	0.19
H		72,500	38,500	29.0	47.0	0.39	0.46	0.015	0.044	0.18

*Nickel steel crankshaft with 0.13 Ni.

per cent antimony, 0.12 per cent phosphorus, 0.05 per cent arsenic and 0.17 per cent iron. The Brinell hardness was 20.8.

A specimen 1½ in. in diameter by 2½ in. long tested gave the following reductions:

Pressure, Lb. per Sq.In.	Thickness, In.
.....	2.500
2,000	2.4995
5,000	2.4980
10,000	2.4880
11,000	2.4810 (Yield point)

This test indicates that bearing pressures can be high without resulting in unfavorable displacement of the babbitt.

It is not claimed that the materials tested are the only ones suitable for Diesel-engine parts. The engineer, however, has the opportunity to choose that material possessing the characteristics he desires to meet a given set of conditions.

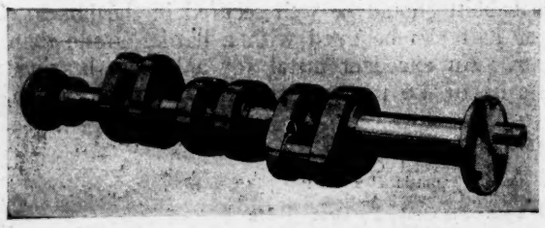


Fig. 3—A built-up crankshaft

Fig. 4—Forged steel rods are popular

Fig. 5—Babbitted bearing shells

Reclaiming a Stack

THE following stack repair is reported by the Lincoln Electric Company:

"In St. Joseph, Mo., is a steel stack 285 ft. high and 16 ft. in diameter. Recently, a fracture occurred about 190 ft. from the base. There was grave danger of the stack toppling and it was about to be torn down by order of the municipal building inspectors. The Kansas City Structural Steel Company saved it by the use of the electric-arc welding process. Longitudinal bars, spaced approximately 6 in. on centers, were added to the surface of the stack, lapping the fracture approximately 6 ft. above and below."

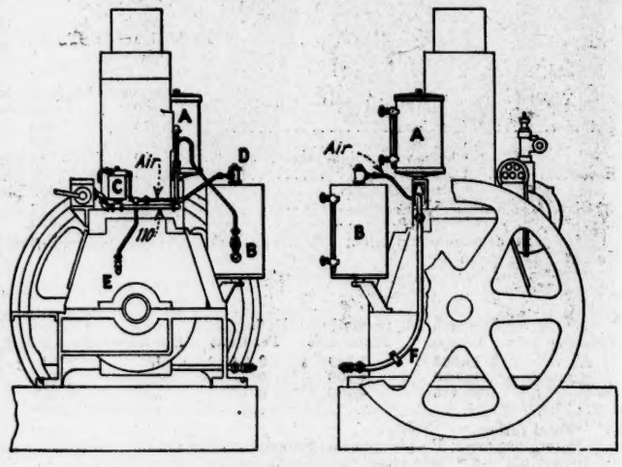
Automatic Oil Filter and Filler

By Orville Adams

THE need for a practical lubricating oil filter working as nearly automatic as possible for two-stroke-cycle crankcase engines led to the development of the apparatus illustrated. The unit automatically takes the dirty, or used, oil from the crankcase, passes it through a filter and returns it to the lubricator as clean oil, without the use of any pumps or like devices.

The system comprises three principal elements: A filter *A* with means for elevating the crankcase drainage into it; a reservoir *B* for new oil, located on the back of the engine, and a regulating device *C* on the lubricator to maintain a constant level of oil supplied from the oil reservoir.

The reservoir *B* is mounted on the back of the engine baseplate and is provided with a gage glass to show the oil level and a filling nozzle. This oil tank is made air-tight and is provided with a connection *D* at the top communicating with the engine crankcase and the float valve. An inspection hole cover *E* on one of the crank housings is tapped for this connection and the pressure existing in the crankcase is communicated to the oil reservoir. A ball check valve in the line traps this crankcase pressure in the reservoir above the oil to cause the transfer of new oil into the engine lubricator. The float valve *C* is mounted behind the lubricator and is connected to the piping leading from the bottom of the lubricator to the bottom of the filter *A*. A rise in the level of the oil in the lubricator causes the float to operate a needle valve which permits the air in the new-oil tank to escape through an atmospheric vent on the float box. With the disappearance of this pressure in the new-oil tank the flow of oil to the lubricator stops.



The automatic filler applied to an engine

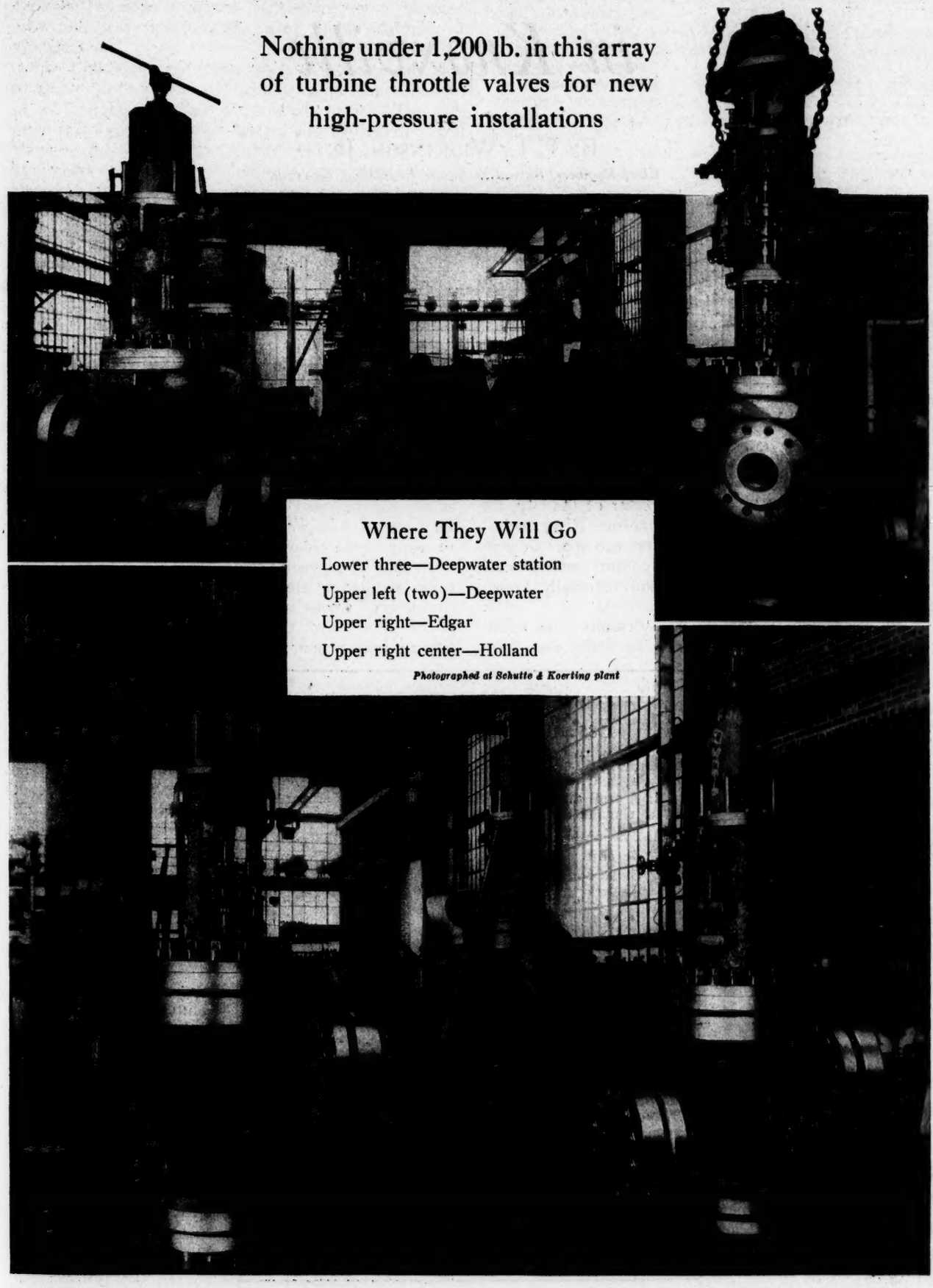
When the level of the oil in the lubricator drops sufficiently for the valve to close again, the air pressure from the crankcase builds up in the new-oil tank *B* and causes a delivery of oil into the lubricator.

Oil from the crankcase drains of the engines is led through a pipe *F* into the bottom of the oil filter. Air under crankcase pressure blowing through the pipe lifts the oil to the filter on the air-lift principle.

It can be seen that this system returns the used and filtered oil to the lubricator without contaminating the new-oil supply. The contents of the new-oil tank are sufficient to make the filling of the lubricator by hand unnecessary as long as any oil is in the new-oil tank.

Valves for High Pressures

Nothing under 1,200 lb. in this array of turbine throttle valves for new high-pressure installations



Where They Will Go

Lower three—Deepwater station

Upper left (two)—Deepwater

Upper right—Edgar

Upper right center—Holland

Photographed at Schutte & Koerting plant

A Year of Smoke Abatement in Knoxville

By F. L. Wilkinson, Jr.
Chief Engineer, Bureau of Smoke Regulation, Knoxville

KNOXVILLE, TENN., a city of approximately 135,000 people, lies on the outskirts of the rich Southern Appalachian bituminous coal fields. It is one of the first cities settled in the State of Tennessee, dating from 1798. In common with most old cities in a hilly country, it, like "Topsy," "just growed" along its ridges and valleys, resulting in narrow and winding streets in the business section. Its several larger office buildings and hotels are flanked by low buildings of an ancient type. Their chimneys are generally on a level with the windows of the higher buildings, resulting in a smoky condition in the offices of the large buildings as well as in the streets.

Two railroads cut through the center of the city, following the valleys and the Tennessee River, which borders the city on the south. There are approximately 350 industrial plants within the city limits, mostly small, but among them several large and nationally known manufacturing concerns.

An exceedingly low wind velocity results in an appreciable number of river fogs during the entire year, more prevalent in the winter than in the summer. A record of the wind velocities since 1871 shows that Knoxville has an average yearly velocity of only six miles per hour.

The foregoing summary of the atmospheric conditions prevailing in Knoxville, together with its topography and an almost universal use of high-volatile coal for heating and power purposes, is sufficient to give an idea as to the bad smoky condition that has prevailed in the city for years.

The need for the regulation of smoke emission has evidently been on the minds of the citizens for a great many years. Agitation to reduce the smoke pall culminated in the passage in 1911, of "An ordinance to provide for the abatement of emission of dense black or dense gray smoke from certain smokestacks or chimneys within the corporate limits of the City of Knoxville, Tennessee; declaring the same to be a nuisance; providing for a Smoke Inspector and prescribing a penalty for the violation of the provisions of this ordinance." A fine was imposed, by ordinance, on the owner of a smokestack that permitted the emission of "dense smoke." The local Building Inspector was charged with the enforcement of the ordinance, armed only with the ordinance itself as a weapon to combat the nuisance.

Citizens immediately became the victims of zealous salesmen who had numerous and sundry "smoke consumers" to sell, guaranteed to eliminate the smoke from all furnaces and heaters. The results of their efforts at salesmanship and the earnest desire of owners to rid their stacks of smoke can still be seen in the boiler rooms of many of the older downtown business houses.

In spite of a general desire on the part of the citizens to be law abiding and the wholesale purchase of "smoke consumers," smoke still persisted in polluting the atmosphere. The Mayor then decided that it was time for the city to take action, and demanded some prosecutions from the Building Inspector. That official armed himself with a pencil and pad, climbed to the roof of the tallest building and cast his eyes over the city. He has told the writer that he could have brought to the city court the owner of almost every building in the city, but contented himself with about fifteen of the most prominent citizens.

The scene in court the following day must have been interesting. All offenders had the same plea, "Guilty, but what can we do about it?" The magistrate was evidently quite wise in the law, but could not come to the rescue of the offenders in offering any solution to their problem, nor could their prosecutor, who had only done his duty in bringing them to justice. It resulted in the magistrate's entering a fine against each and suggesting that they appeal to the City

Essentials for a Successful Smoke Campaign

1. **A well directed preliminary campaign designed to make the public want smoke abatement.**
2. **The passage of a complete ordinance that can be enforced without unnecessary hardships on those concerned.**
3. **The complete removal of smoke abatement from the police department.**
4. **The necessity of appointing an experienced engineer, not only to carry out the provisions of the ordinance, but to gain the respect and confidence of the public.**
5. **Reduce prosecutions to the minimum and prosecute violators only when other methods fail.**
6. **Start the work with a small budget and personnel, increasing it only after the work of smoke abatement has proved itself in the minds of the public.**
7. **Enlist the aid and support of the press. Without its aid and co-operation little can be accomplished.**
8. **Most essential of all, keep smoke abatement free from political influences.**

Council, which was duly done. The Council heard the appeal, remitted the fines and adjourned. The ordinance remained on the statutes until March, 1928, when the present smoke abatement ordinance was passed. The Building Inspector remained "Smoke Inspector" in name only and was never again called upon to bring in offenders.

The City Manager-Council form of government came to Knoxville in 1923, and with it came many changes of an enlightening and worth-while nature. The city grew rapidly. Its sanitary system was expanded, a new water works was built and public health and public welfare was undertaken in earnest. Its streets became cleaner, a Bureau of Recreation was established, a City Planning Commission appointed, but soot and grime reigned supreme and continued to take its toll of the city's health and wealth.

A group of far-sighted citizens composed of housewives, merchants, doctors, lawyers, engineers, business men and manufacturers, formed a Smoke Abatement League and started in earnest to demand clean air to breathe as well as pure water to drink. Their campaign was well directed and ably managed. A monthly soot-fall determination was made over the city by the Chemistry Department of the University of Tennessee from January, 1927, to January, 1928, and it was discovered that the average yearly soot-fall over the city amounted to 266 tons per square mile. It was estimated that the cost to the citizens of Knoxville of a soot- and smoke-laden atmosphere was approximately $17.50 per person per annum.

A committee composed of councilmen, engineers and laymen was appointed by the Council to draw up a smoke-abatement ordinance for its consideration. They adopted the Standard Ordinance of the American Society of Mechanical Engineers with minor changes that made it conform more nearly with local needs.

All civic clubs, the manufacturers' association, the local section of the A.S.M.E., the local chapter of the N.A.P.E., the Technical Club, ladies' clubs and kindred organizations sponsored the ordinance and it met with little opposition in Council, passing on final reading March 13, 1928. This was a very different ordinance from that commanding stacks to cease smoking, passed seventeen years previous.

The ordinance starts off in a very businesslike manner, creating a "Bureau of Smoke Regulation, the chief of which shall be known as the Chief Engineer, Bureau of Smoke Regulation," and placing the bureau under the Department of Public Welfare. It is significant that the Chief Engineer, Bureau of Smoke Regulation, "shall be an engineer qualified by training and experience in the theory and practice of the construction and operation of steam boilers and furnaces and also in the theory and practice of smoke abatement and prevention." This phrase alone takes the enforcement of the city's ordinance out of the hands of the political appointee and places it in the hands of an engineer technically educated and trained.

In brief, the ordinance makes the following provisions:

1. Provides for a Bureau of Smoke Regulation under the Department of Public Welfare with a technically trained man at its head.

2. Provides for an Advisory Board, to serve without pay, of not less than five members, three of whom shall be mechanical engineers, who shall act as advisers to the Chief Engineer.

3. Provides that the ordinance shall apply, in substance, to all fuel-burning equipment except in a private residence.

4. Prohibits the emission of smoke equal to or greater than No. 3 Ringelmann chart for a period in excess of two minutes in any fifteen, except for a sufficient period of time necessary for starting and cleaning fires. The time limit is reduced to one minute in any eight for locomotives, steamboats, steam rollers, etc.

5. Provides that a permit be obtained for the installation of new fuel-burning equipment or for alterations and repairs to existing equipment.

6. Provides penalties for owners or contractors installing equipment without obtaining permits from the Chief Engineer, Bureau of Smoke Regulation. No charge is made for these permits.

7. Provides that owners shall make changes recommended by the Chief Engineer looking toward the reduction or elimination of smoke within thirty days of the date the recommendations are made.

8. Provides that the owner or contractor shall have the right to appeal to the Advisory Board from the decisions of the Chief Engineer, and further provides that the ruling of the Advisory Board shall be binding on the Chief Engineer.

9. One long section of the ordinance contains recommendations as to new installations concerning setting heights of boilers, etc., and, in fact, establishes a code that shall serve as a guide to the purchasers and manufacturers of equipment. This code was first proposed as a requirement, but was wisely changed by the Council to serve only as a guide. The wisdom of this change has been brought out even in the short time of the ordinance's existence due to the constant advance in the design of heating boilers and furnaces.

10. The ordinance further provides that no prosecutions can be made unless instituted by the Chief Engineer, Bureau of Smoke Regulation.

The penalties are perhaps not sufficiently heavy, but they are heavy enough to give the ordinance teeth.

To find a man who could enter the duties of Chief Engineer and meet the standards set by Council was the work of the Director of Public Welfare. The smoke abatement ordinance was close to his heart, as he had worked diligently to have it passed, and from the several applicants for the job he was unable to find a single engineer who he believed could fill the qualifications unless given special training, nor could he find many who were willing to undertake the work without at least a short period of time under the training and counsel of one who had had experience in directing the work of such a bureau.

In view of this fact, the City of Knoxville employed John Hunter as Consulting Engineer to remain in Knoxville for a period of three months in order to start the work and train an engineer to follow in his footsteps as Chief Engineer of the Bureau.

With the record of two other Southern cities well on the way toward smokeless skies behind him, Mr. Hunter came to Knoxville in June, 1928, and an intensive campaign was started toward the reduction of smoke from the stacks of the industrial plants. The citizens were won for smoke abatement at once by the knowledge that their smoke would be eliminated solely through sound economical and engineering methods. It soon became apparent that "big stick" methods would not be employed, but that the campaign for smoke abatement in Knoxville would be conducted on an educational basis and that all changes recommended would be made from an engineering point of view.

It is considered fortunate that the work started in the spring, when heating plants were idle, and three months were available in which to concentrate on the industrial plants. It is useless to urge smoke abatement on the heating plant owner as long as the tall stack is smoking badly and the owner is making no effort to reduce its smoke emission. So the three summer months were

devoted almost entirely to the industrial plants and the railroals.

The industrial plant owners were ready and only waiting to find out what they should do toward smoke elimination. Recommendations were made covering over three hundred power boilers during the three summer months, and approximately 85 per cent of these boilers were changed in accordance with the recommendations made before the fifteenth of September.

In recommending changes in methods of operation and in reconstructing boiler furnaces, the financial ability of the owner, the nature of the plant operation, etc., were taken into consideration. Where a plant was financially able to make the necessary expenditure for proper fuel burning equipment and the returns on the initial investment seemed justified, they were urged to install underfeed stokers or similar equipment, and the economic benefits were pointed out. In the case of the small plant, burning comparatively small amounts of coal, the use of simple and inexpensive air jets was resorted to, with no promises of exorbitant fuel savings or wide economic benefits beyond those to the community resulting from the elimination of smoke. Where plants reaped their harvest during the summer months, such as ice plants and ice cream factories, they were not asked to shut down and make changes that would shorten their periods of greatest profits. As a result, every plant of this nature made the recommended changes without further urging during the ensuing winter.

The engineers of the bureau tried on every occasion to drop some useful hints toward fuel conservation beyond those for abating smoke, which in many cases have resulted in the further saving of fuel and have helped to popularize smoke abatement among the industrial plants.

A wise City Manager and Council realized that if the city was to be cleaned of its smoke, it would first have to "clean its own front porch." As a result they contracted for the installation of two stokers and purchased coke for all civic buildings and city schools not equipped to burn bituminous coal without the emission of dense smoke. Next year the Bureau of Smoke Regulation will have a vital part in the purchase of all fuel burned by the city, and it is believed that a decided reduction in loss from that source will result.

The heating plants have been a problem during the past heating season, but the same spirit of co-operation prevailed among the owners of heating plants that was apparent in the industrial field. Furnace changes, fuel changes, proper firing methods and the installation of stokers have marked the progress in this field.

As is common in most localities where cheap fuel is obtainable, the very cheapest form of cheap fuel has been the rule. Education in the values of the different sizes of fuel and the better utilization to be derived from the use of screened and sized coal, has led to a demand for a better and higher-priced fuel on the part of the consumer.

The assistance of the retail coal merchants was solicited, and while they were more or less inactive at first, they have now organized and are putting on an active campaign employing efficient service men to instruct their customers in the proper use of domestic fuel. Their slogan will be "The proper fuel in the proper place."

The domestic user, though not covered by city ordinance, is of course a bad offender during the heating season. The bureau has tried to reach this class by education through the press, placards on street cars and pamphlets and cards of instruction placed in the homes by Boy Scouts. The bureau made its small personnel available for calls from home owners to give instruction in the necessary care in tending their boilers and furnaces to produce as little smoke as possible.

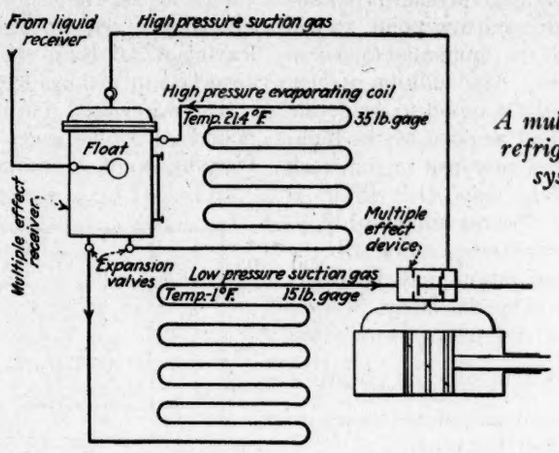
The railroads are still a source of much annoyance, but their co-operation has been splendid and a decided improvement has already been made. It is the policy to report a few offending locomotives to the railroad superintendents once each week and allow them to handle such violations within their own organizations

A very limited budget and personnel was requested for the first year of smoke abatement. It was thought that more could be accomplished by getting along with a small budget at first and asking for an increase when the worth of smoke abatement had been established. It is felt now that this policy was justified, and almost double the amount expended will be asked for next year.

The results of this first year have been gratifying. The University of Tennessee started another survey of the soot-fall within the city limits in February, and the results for February, 1929, compared with those for the same month in 1927, showed gratifying reduction.

In spite of the apparent reduction in soot-fall shown in the available determinations, Knoxville is still a smoky city, and it is no doubt hard for the average citizen to realize the extent of the improvement, although it is now becoming apparent. It is felt that the progress made is due to the splendid co-operation of the city administration and the citizens themselves. The city is rapidly becoming "smoke-abatement conscious" and with increased personnel, resulting in closer supervision, it is hoped that future improvement will make itself felt by the most careless observer.

> The small buildings, with their low stacks in the congested areas, have been quite a problem. In most cases their smoke emission has been reduced to within ordinance limits, but the low stacks and low wind velocity have made them continue to be objectionable. The plan for remedying this nuisance before the next heating season is the establishment of six "block heating systems." The smaller buildings are to be heated from the larger ones in each block. The nucleus for a general adaptation of block heating in the congested area will be from six of the larger office buildings, hotels and department stores. With this nucleus it is expected to eliminate 34 of the smaller and offending chimneys.



A multi-effect refrigeration system

Multiple Effect Compression *Increases Plant Capacity*

by enabling more gas to enter the compressor, and by cooling the ammonia liquid at a high pressure outside the coils

By

FRANK P. MACNEILL

OF THE many efforts made to improve the efficiency of the compression refrigeration system, the multiple-effect compression idea, developed by Gardiner Voorhees, has attracted much attention, but, while used to some extent, it has not been adopted as generally as it deserves.

It is not compound compression, but may be applied to compound as well as single compression systems.

Briefly, the idea is to make one machine perform a multiple duty of handling gas at more than one suction pressure. This is accomplished by filling the cylinder with suction gas at a low pressure and then allowing high-pressure suction gas to enter the compressor cylinder near the end of the suction stroke, just prior to the reversal of the piston travel.

The compression action follows that outlined in the indicator diagrams. In one a low-pressure gas at 15 lb. is admitted into the cylinder and is compressed to 150 lb. gage; a second shows a high-pressure gas entering the cylinder after the latter has been charged with low-pressure gas and the combined charge being raised to 150 lb. pressure. The two compression lines are compared in the third diagram.

There is more than one method employed to charge the cylinder. A port may be uncovered at the end of the stroke or two ports may be uncovered in succession, thus admitting, progressively, gases at higher pressures to compress those already admitted. Where only two suction pressures are used, a device may be fitted in the suction line close to the machine, and actuated by a rod connected to the moving parts, to cause a shuttle valve in the device to admit both suction gases at their proper periods of the stroke. This latter method obviates the necessity of new cylinders and is the one illustrated.

A multiple-effect receiver is sometimes used in conjunction with the Voorhees multiple-effect compressor. This device is an inclosed vessel containing a float-actuated admission valve. Into this vessel the ammonia liquid from the condensers or regular liquid receivers is admitted and kept at a predetermined level by the float valve. Owing to the drop in pressure some of the liquid evaporates and passes from the upper portion of this vessel to the suction side of the compressor. This usually constitutes the "high-pressure suction" in a dual-compression layout.

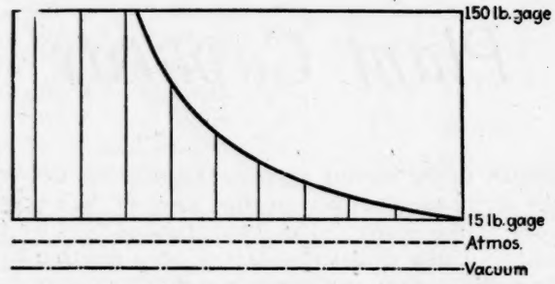
The pressure in this vessel is kept higher than the regular suction pressure, and the suction line from coils in which refrigeration is done at a high back pressure is usually led into it and from thence to the compressor, as shown.

From the lower portion of the vessel liquid ammonia, at a lower temperature than when it entered, is led away to the various high- and low-pressure expansion valves. In some cases the liquid to the low-pressure expansion valves is further cooled by passing it through a liquid coil within an accumulator in the low-pressure suction line.

To understand some of the claims made for the economy of this idea, it is necessary to use a given set of operating conditions and work out the example. When saturated liquid ammonia at 150 lb. gage pressure, and at the corresponding saturation temperature of 84.4 deg. F., passes through an expansion valve into a coil where the pressure is 15 lb. gage, the saturation temperature being —1 deg. F., each pound weight of liquid carries with it 137 B.t.u. Within this coil liquid

ammonia at —1 deg. F. and 15 lb. gage pressure contains 41.9 B.t.u. reckoned from the same starting point, as will be found from examination of the ammonia tables in "Power's Practical Refrigeration." Any addition of heat beyond 41.9 B.t.u. causes some of the liquid to evaporate at that pressure. It is obvious that as soon as the high-pressure liquid passes into the low-pressure region, each pound contains 137 B.t.u., while only 41.9 B.t.u. is needed by it in its liquid state. The remainder (137 — 41.9) is going to cause a partial evaporation of the liquid. The extent of this evaporation may be easily found by dividing this difference by the latent heat of evaporation at the coil pressure and temperature; thus $\frac{137 - 41.9}{569.5} = 0.166$, or 16 per cent of each pound of liquid ammonia that enters the coil evaporates owing to the excess of the contained heat of the liquid.

The vapor formed from the evaporation of this 16 per cent of each pound takes useful space in the coils and has to be handled by the compressor along with the vapor that results from useful evaporation. Now, if the high-pressure liquid can be cooled outside of the coil to a temperature near that prevailing within the coil, it can be seen that there will be but very little useless evaporation of the entering liquid; consequently, the coil



Compression of a single-pressure suction gas

can evaporate more liquid for useful work and the compressor can do more useful work.

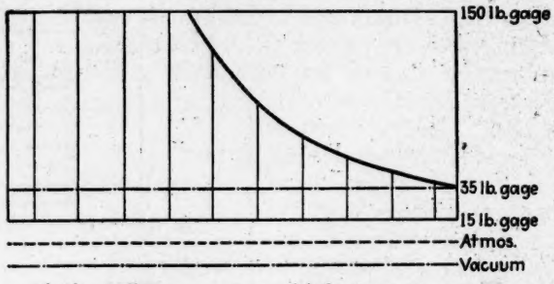
The vapor formed from the cooling of the liquid outside the coil will have to be handled by the compressor just the same, but if handled at a high back pressure the volume of the vapor per pound weight is not so great as at a low pressure, which means that the compressor does not have to be so large.

Now, if the high-pressure liquid is led into a multiple-effect receiver, where a pressure of, say, 30 lb. gage is maintained, a little over 13½ per cent will evaporate and cool the remainder to 16.6 deg. F., so that when the remaining liquid reaches the coil there will be only an initial evaporation of 3⅓ per cent. The vapor from the 13.5 per cent evaporated at the high pressure may now be led, with other vapor resulting from high-pressure refrigeration, to the compressor and admitted at the end of the low-pressure stroke.

Let us consider an ice plant operating with 150 lb. gage condenser pressure and a corresponding condensing temperature of 84.4 deg. F. A suction pressure of 15 lb. gage with a corresponding evaporating temperature of —1 deg. F. exists in the tank coils. Further, let it be supposed that there is no precooling of the liquid ammonia between the condenser and ice-tank coils.

The heat of the liquid at the condensing pressure and temperature before the expansion valve is 137 B.t.u., and the heat of the liquid in the coil after the expansion valves, 41.9; the heat difference, 96.9 B.t.u., will boil off 17 per cent of each pound of liquid that enters, leaving 472.6 B.t.u. of the latent heat per pound to be absorbed in making ice.

The water used to fill the ice cans is at 70 deg. F. and a pound of water gives up 38 B.t.u. in cooling to the freezing point. The latent heat of freezing the water

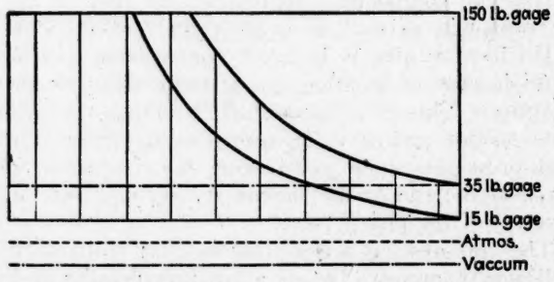


Action when a gas at a higher pressure enters

at atmospheric pressure may be taken as 144 B.t.u., and the specific heat of ice down to the temperature of the brine, 15 deg. F., is 0.49 B.t.u. per pound per degree. Summing up we have 190.33 B.t.u. required to convert a pound of water at 70 deg. F. into ice at 15 deg. F. without considering heat leaks into the system. This, divided into 472.6 B.t.u., the remaining latent heat, gives the number of pounds of ice (2.48) that each pound of liquid ammonia entering the coils will produce. The vapor resulting from the primary evaporation has to be included in the vapor volume resulting from ice making, so one pound of vapor at a temperature of —1 deg. F. and occupying a volume of 9.32 cu.ft. goes to the compressor. The heat equivalent of the power required to compress this pound of vapor, not considering losses incidental to compression, is 108 B.t.u.

If a forecooler is installed in which the 70-deg. can water can be cooled down to 32 deg., the forecooler can be operated at a high suction pressure. The vapor from this high-pressure cooling will occupy less space in the compressor and will require less power to compress it.

Suppose we select 35 lb. gage as the pressure at which

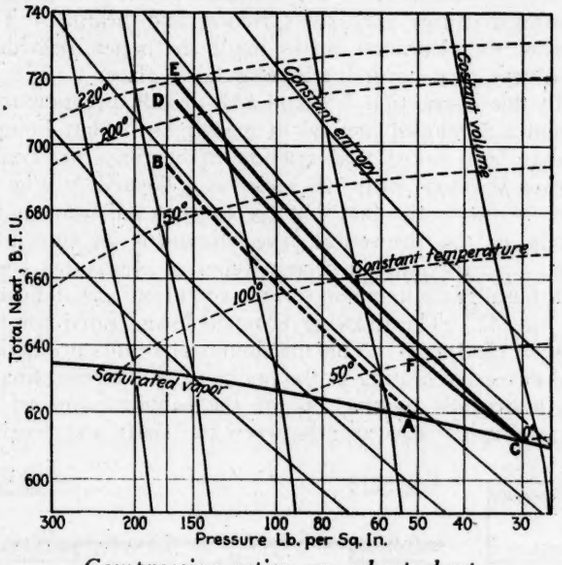


Comparison of the difference in work per stroke

to operate the cooler. By using a multiple-effect receiver, we can take the warm ammonia liquid leaving the condenser and allow it to drop in pressure to 35 lb. gage in the multi-effect receiver. In doing so, the difference in heat contents will boil off 12.8 per cent of each pound of liquid that enters the receiver, leaving 87.2 per cent to cool the water and make ice. Cooling the water requires, roughly, 20 per cent of the entire heat taken up in making ice, so at this pressure it will require 38 B.t.u. of the latent heat, or 6.8 per cent. This

leaves 80.4 per cent, and as 24.4 B.t.u. is lost in primary evaporation upon the liquid entering the coils, 433.47 B.t.u. is absorbed in making 2.84 lb. of ice, as against 2.48 lb. of ice made without precooling and multiple-effect, an increase of production of 14.5 per cent.

The heat equivalent of the power required to compress this 80.4 per cent of the pound of vapor up to the pressure of the high-pressure suction is 23.27 B.t.u., assuming that it is done without loss, and it makes no difference whether the compression is done by a piston or a vapor pressing upon a vapor. The temperature that should prevail at the end of compression is 57 deg. F. However, the high-pressure suction vapor is at 21.4 deg. F., and as the weight of this gas taken into the compressor is only about a fourth of the low-pressure suction charge, on mixing in compression, the high-pressure suction will absorb some of the heat of compression and will reduce the temperature of the total vapor volume to around 49 deg. F. before the piston starts on its compression stroke. The heat equivalent of the power required to compress this whole pound of vapor from



Compression action on a heat chart

35 lb. to 150 lb. gage and deliver it to the condenser is 103 B.t.u., as compared with 108 B.t.u. required without precooling and multiple-effect cylinder charging. By plotting the action in the compressor, in both cases, on a Mollier chart, by transferring pressure volume conditions from indicator diagrams it will be found that with multiple-effect the compression curve of the low-pressure suction follows the path *CF* to *F*, at which point the cylinder is completely charged with the high-pressure suction. Compression then is along the line *FD* instead of *CE*, as in the normal one-suction compression. Ordinarily, gas at the high-suction pressure would follow the line *AB* in compression.

The volumes occupied by both suctions will be smaller than in the first case, so that a smaller cylinder will do the same work, or a greater weight of vapor may be pumped with the cylinder required for the first case.

The volume occupied by the low-pressure suction vapor after compression to the high-pressure suction pressure is 4.97 cu.ft., leaving 1.21 cu.ft. for the high-pressure suction to occupy. The volume of both being 6.18 cu.ft. as compared to 9.32 cu.ft. in the first case. it follows that if a cylinder 24x36 in. is required in the first case, a cylinder 21x31 in. will hold the same weight of vapor in the second case.

Using the 24x36-in. cylinder with multiple effect, the first gain comes from the fact that only 0.804 instead of one pound of vapor is evaporated at low pressure for every pound of liquid circulated, and as one pound is admitted into the cylinder, we have a gain of 23 per cent. The pound of vapor after compression occupies 6.18 cu.ft. and as there is 9.32 cu.ft. of cylinder volume, there is obviously room for 3.14 cu.ft. of high-pressure suction vapor, or over half a pound. Therefore, the 24x36-in. cylinder under multiple-effect conditions is capable of handling 1.5 instead of one pound of vapor per stroke.

If the heat equivalent of the work per pound of vapor compressed is in the first case 110 B.t.u., by using multiple effect, 1.5 lb. of vapor is compressed at the expenditure of 154 B.t.u., a power reduction of 7 per cent. Now we have seen that 2.48 lb. of ice can be made per pound of liquid in the first case, and that 2.84 lb. of ice per pound of liquid in the second case, so now we have 1.50×2.84, or 4.26 lb. of ice produced by $1\frac{1}{2}$ lb. of liquid ammonia with the same cylinder as used in the first case. The power reduction would be 18.6 per cent and the increase in capacity of the machine 58 per cent.

It must be remembered that while certain factors not considered will operate to reduce the gains shown, these same factors will tend to reduce the efficiency of the cycle where no precooling and multiple-effect is followed. When all is considered, giving each factor its weighted value, the two-suction system with precooling shows a real gain.

On May 28—

POWER will answer the following questions in an outstanding number devoted exclusively to an interpretation of the new era of high steam pressures and temperatures:

What plants use them (high pressures and temperatures)?
Any troubles?
First cost high?
Does it pay?
Are the boilers safe?
—and turbines reliable?
What materials will stand up?
Wouldn't an engine be better than a turbine?
What of superheaters and reheating?
How about feed pumping and treatment?

The first comprehensive survey of the high-pressure situation!

Right Out of the Plant

Protection Against Shock Necessary When Filtering Oil from Live Transformers

RECENTLY, through the electrocution of an oil-filter attendant, an unusual source of danger was traced down. The man, who was operating an oil machine, filtering the oil in a substation transformer, was killed by touching the valve that controlled the oil flow. The machine, though thoroughly grounded to the

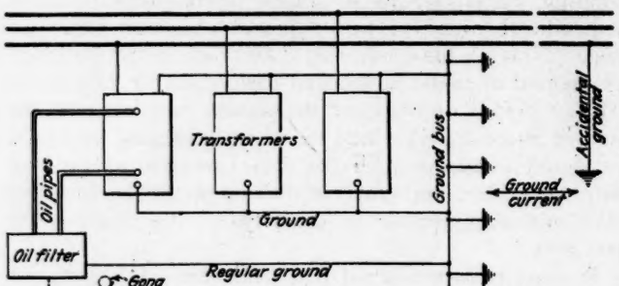


Diagram showing transformer and oil-filter connections, also filter auxiliary relay

substation ground bus, was found to be "hot" to the ground on which it was standing.

The circumstances that led up to this condition were investigated and found to be that a high-voltage phase wire of the star-connected grounded-neutral line had broken and dropped to the ground, causing a fault current to flow between the substation ground and the grounded phase wire. This occurred in hot, dry weather, so the fault current was limited by high ground resistance at both places, therefore it did not open the overload breaker nor blow an oil fuse. For this reason the ground current was sustained over a considerable period of time, so that the substation ground baked out until its resistance was high. The oil-filter attendant then, standing on ground somewhat removed from the substation, touched the machine which was connected to the substation by means of the ground wire. This offered a comparatively low resistance ground path through the operator's body, with fatal results.

All such machines are now protected by a relay, as shown in dotted lines at *A*, especially designed to operate a gong to notify the operator in case there is any danger of a similar condition existing. The relay is simply an instantaneous over-current relay with low-resistance winding, which is connected to the machine and in series with a temporary ground rod to be driven by the attendant when the filter is set up. Any ground current in this line closes the relay, which latches shut, so that in case of burn-out of the coils or baking out of the ground the alarm will continue to ring, as a warning not to touch the machine. All operators are instructed that the machine is not to be touched after operation of this relay until a known ground wire has been touched to the machine by means of a "hot stick" and no flash observed.

Machines have been known to become "hot" by offering a ground path parallel to the substation ground when an insulator flashes over to ground. This relay will also operate under these conditions.

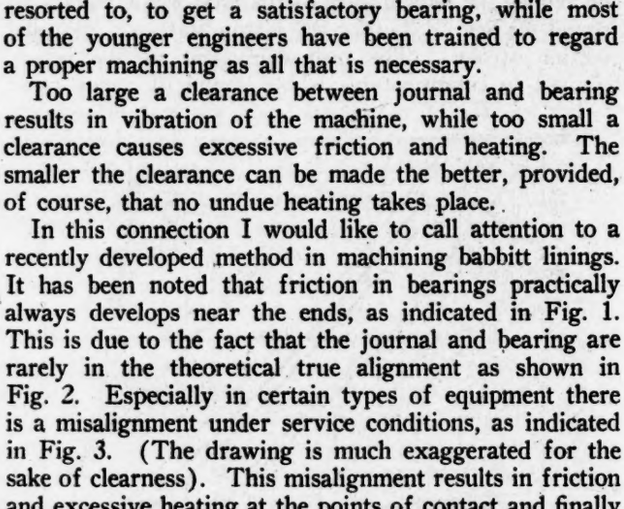
Oklahoma City, Okla. D. C. HARDER,
Oklahoma Gas & Electric Company.

Pointers on Machining Bearings

THERE is much difference of opinion among engineers on the proper method of fitting bearings. Some of the older school contend that scraping must always be resorted to, to get a satisfactory bearing, while most of the younger engineers have been trained to regard a proper machining as all that is necessary.

Too large a clearance between journal and bearing results in vibration of the machine, while too small a clearance causes excessive friction and heating. The smaller the clearance can be made the better, provided, of course, that no undue heating takes place.

In this connection I would like to call attention to a recently developed method in machining babbitt linings. It has been noted that friction in bearings practically always develops near the ends, as indicated in Fig. 1. This is due to the fact that the journal and bearing are rarely in the theoretical true alignment as shown in Fig. 2. Especially in certain types of equipment there is a misalignment under service conditions, as indicated in Fig. 3. (The drawing is much exaggerated for the sake of clearness). This misalignment results in friction and excessive heating at the points of contact and finally in failure and melting out of the babbitt. Instead of increasing the clearance between the shaft and bearing



Increased clearance at bearing ends reduces heating

over the whole length of the bearing, it has been found much better to machine the babbitt as indicated by the dotted line in Fig. 4, making the clearance at the ends one to two thousandths of an inch greater than in the center of the bearing. This method of machining has given excellent results. A simpler method consists in taking off one to two thousandths of an inch for a distance of one to two inches from each end, as indicated in Fig. 5.

A babbitt metal must be hard enough to take the wear, but must also possess a certain degree of softness, so that it will yield in compression sufficiently to conform to the journal. Other conditions being equal, a babbitt lining having both properties mentioned will not require scraping, while a babbitt that does not conform to the shaft will need scraping at places where friction develops, since the babbitt does not yield.

Chicago, Ill. JAMES SILBERSTEIN.

Detecting Smoke at Chimney Tops

I have read the suggestions given by several readers on the best method of detecting smoke at chimney tops, so offer my own method.

The volume of smoke emitted from the two stacks may be observed from the boiler room by means of a comparatively simple arrangement if a point can be selected from which a clear view of the stacks can be had and if this point can also be seen from the boiler room. At this point it is only necessary to place a convex mirror, and by proper adjustment the image of the stacks can be seen from the boiler room.

For the stacks in question a convex mirror of 20 in. diameter and with a focal length of about 40 in., should serve the purpose. The size of image and field range are controllable by varying the diameter and focal length of the mirror to be used. The distance from the observer to the mirror should not be more than 50 feet.

If, however, it is not possible to place the mirror in the way described, an arrangement that may be termed an "open periscope" can be used. Place the convex mirror at a point where a clear view of the stacks may be had, in such a way that a reflection of this mirror will be visible in a plane mirror placed within ten feet of the observer. The stack reflection in the convex mirror will then be visible in the plane mirror when properly aligned.

Brooklyn, N. Y. BARRY M. TURNER.

Steam-Flow Air-Flow Meters

WITH reference to the question in the April 16 number, "Does the meter showing air flow to the furnace and the steam flow eliminate the CO_2 instrument as a necessary boiler room adjunct?" I would say that the popularity of the steam-flow air-flow meter is largely due to the fact that its performance has been more satisfactory than the average CO_2 recorder. In most plants, after these instruments have been checked and placed in operation by the use of an Orsat, no further check is made until something happens and the meter ceases to function. This condition is one that leads to a reliance on the instrument indications that may permit considerable loss to exist and go unnoticed for a period of time, until next checked.

One thing I have noticed in my travels about the country is that too many engineers expect that boiler instruments, after being placed in service, will function indefinitely, and they are not checked or noticed particularly unless they cease to operate. Then the service man is called and again they are left to their own devices.

It is not too much to ask of any first-class engineer or mechanic to spend a couple of hours familiarizing himself with instruments that would aid him so much in his work. None of the present types on the market are so involved in design or performance but what a couple of hours' study would enable the engineer to know and obtain the best results from his instruments, thereby getting data and facts that are valuable from both the operating cost and design points of view.

The theory of the steam-flow air-flow is to supply the proper amount of excess air based on the fuel characteristics at the time the instrument is checked with an Orsat. Therefore, the true relation between steam-flow air-flow occurs only while the fuel characteristics and boiler-setting conditions remain constant. As the CO_2 is the indicator for the proper amount of excess air desired, we prefer to use the CO_2 indication direct, as it eliminates other variables such as fuel characteristics changing, when a change over is made from oil to gas or vice versa, leaky settings or baffles, and we do not agree that the steam-flow air-flow eliminates the CO_2 recorder from the boiler room, but believe they should supplement one another in order to maintain best conditions at all times.

Los Angeles, Calif. GUY L. WARDEN.

Experiences with High Pressures

I READ the article by Richard Brown in the April 2 number on "Experiences With High Pressures," with a great deal of interest. My experience has been that when you visit a plant to try to learn the difficulties encountered, there are none. Everything is going along very smoothly, with few men on the payroll and maintenance practically nothing. But are these real facts? Too many times I fear these statements won't bear investigation. "Our boilers do 500 per cent rating day after day," but these figures are based on pounds of water evaporated by the boilers and the water-cooled furnaces are forgotten.

How many plants today have a construction crew on the job making improvements and taking care of maintenance? For example, a number of boilers with water-cooled refractory walls are installed in a station. About the time the walls are ready to fall down it is decided to change to a new type of burner. This makes it necessary to rebuild the old walls to accommodate the new installation, so the work is taken care of by the construction crew with no maintenance charge.

Boiler-feed pumps used with high pressure and temperature, such as Mr. Brown has, are always a source of more or less trouble. Packing, sleeves, joints and thrust bearings usually give plenty of trouble.

Let us hear from Mr. Brown again and others who are not afraid to tell their troubles and remedies, as well as the good points, in their respective stations.

H. K. GINGERY, Master Mechanic,
Pennsgrove, N. J. Stevens & Wood, Inc.

Stream-Flow Prediction for Power Generation

THE article in the April 16 number, "Sun Spots a Factor in Predicting Stream Flow for Power Generation," by A. Streiff is very interesting. In the early days of operation at Keokuk I was much interested in the possibility of using rainfall cycles as a basis for predicting stream flow, but have long since given up the idea as being of any particular value in our case. In 1918 R. H. Bolster, then hydraulic engineer of the company, made a rather comprehensive study of rainfall cycles as they might apply to the Mississippi River drainage above Keokuk, but he did not come to any

definite conclusion as to its value. He summed up his study in part as follows:

"Apparent rainfall cycles are just tangible enough to invite further study of the laws governing periodic variations of annual rainfall and elusive and uncertain enough to render all predictions based on them of very doubtful value, if not utterly worthless."

Our experience since that time has further confirmed this view, at least so far as it applies to conditions at Keokuk. In a low-head run-of-river plant such as this, predictions of annual rainfall would be of no value unless the distribution and intensity of this rainfall could be determined with reasonable accuracy. The plant is affected not only by low water, but also by high water, and quite seriously by the latter on account of reduction of head. Unless one can positively determine that a certain river condition cannot occur within a given length of time, it is not likely that much money will be banked on one's prediction. Other things being equal, the average course is, in our opinion, the only dependable one.

Predictions of river flow at Keokuk start with a general knowledge of storage conditions in the headwaters of the drainage and the condition of the soil in the lower part of the drainage area. Upon this basis and the weather predictions of the United States Weather Bureau and subsequent reports of river stages, we build our estimates of flow at Keokuk. Our budget of power generation is based on the average daily power available for a fifty-year record. The worst low-water and the worst high-water conditions are expected to occur at any time in their respective seasons.

ALBION DAVIS, Chief Engineer,
Keokuk, Iowa. Mississippi River Power Company.

THE articles by A. Streiff in the April 16 and 30 numbers are interesting, and it is surprising how many angles of approach are open to a practical problem. After some years of experience and study I have developed a method of forecasting seasonal runoff which I believe to be of general application and usefulness, tending to increase the commercial efficiency of hydro-electric plant operation.

The hope of profit from operation is based on the preliminary investigation and estimate of the available water supply; the development cost is represented by the investment in design and construction; and operating results are expected to show sufficient profit to justify the development cost. The maximum profit can never be realized unless the estimate of available water supply is actually realized in amount and distribution. An engineering study of runoff records for the purpose of preparing forecasts of the runoff expected seasonally from a drainage area is therefore suggested.

For the sake of obtaining a certain degree of practical simplicity suppose the data of the problem be classified as follows:

A. Data, which may be readily calculated.
   1. Amount and distribution of runoff.
   2. Amount of available storage.
   3. Commercial value of generated power.

B. Irreducible data, which cannot be reduced to mathematical terms.
   1. General topography, hydrology, and geology of drainage areas.
   2. Precipitation, evaporation, and temperature characteristics of drainage areas.
   3. General business conditions and market for generated power.

From a study of the record of the daily discharges, duration curves, etc., certain relations are developed which may be considered runoff characteristics for an individual drainage area or for a group of drainage areas having similar general characteristics peculiar to location, topography, etc. These runoff characteristics may be shown graphically by:

1. Mass curve of mean annual runoff and its monthly distribution in terms of percentage of mean annual runoff.

2. Series of graphs showing for each year of record the monthly distribution of runoff in terms of percentage of mean annual runoff.

3. Graphs representing the accumulated departures from the normal for each year of record, separate graphs being drawn for each of the following periods:
   (*a*) High-stage months
   (*b*) Medium-stage months
   (*c*) Low-stage months
   (*d*) Yearly period.

From the point of view of hydro-electric plant operating requirements those months of the year usually showing a water deficiency are most important, and the available storage should be used so as to supplement to the best advantage the natural low-water flow from a drainage area. The commercial value of power generated from a stream is specified in the power contract and may vary from month to month during the year, and may also have different values for the peak and off-peak hours of the day or week.

A fortunate appraisal of probable seasonal runoff conditions in advance, so as to take advantage of the maximum income possibilities within the contract limitations and adapt storage use to suit, means that at the end of the high-stage period attention should be focused on the probabilities for the medium-stage and low-stage months intervening before the next high-stage period. This is the basis of the method of forecasting runoff here outlined, and the series of graphs previously mentioned disclose certain apparent cyclic tendencies. Extending the graphs accurately depends on the experience and judgment of the person undertaking to interpret the record.

Additional storage provided in a drainage area would change the conditions:

1. The normal yearly runoff would be decreased on account of evaporation from additional water surface.

2. The normal runoff for the high-stage months would be decreased according to the additional storage capacity provided.

3. The normal runoff for the medium-stage and low-stage months would be increased, depending on the method of operating the additional storage.

The factors mentioned can be allowed for, and the provision of additional storage facilities need not vitiate the preceding data or method of forecasting seasonal runoff.

While the foregoing discusses only the "reducible data," the "irreducible data" should never be ignored in judging the characteristics of a drainage area. Their effect is important on the result obtainable at any power site, and such data reflect some of the conditions that cause the facts that are later recorded. To a proper understanding of the primary conditions affecting operation of a hydro-electric plant the "irreducible data" may sometimes contribute more than the "reducible data."

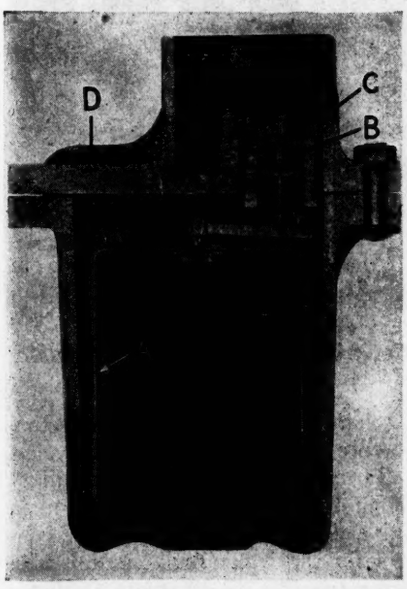
A. H. DAVISON,
Glens Falls, N. Y. Sherman Island Power Plant.

What's New in Plant Equipment

HOW THE MANUFACTURER CONTRIBUTES TO THE JOB OF GENERATING TRANSMITTING AND APPLYING THE POWER SERVICES

New Inverted Bucket Steam Trap

A NEW steam trap of the inverted bucket type, designated 20 Series, is a recent addition to the line of traps put out by the Strong, Carlisle & Hammond Company, Cleveland, Ohio.



Cross-section of 20-series trap

The new trap, which is being built for all operating pressures in semi-steel bodies up to 225 lb. pressure, is of comparatively simple design and has few operating parts. With the exception of the bucket *A*, which is made of spun copper, all operating parts are made of "Anum-Metl" a special non-corrosive steel developed by the manufacturer. The bucket *A* is weighted to give maximum pull on the valve mechanism.

In operation, as the body of the trap fills with water, the bucket fills with steam and air, causing it to become buoyant and hold the valve closed. Then, as the steam and air pass through the vent in the top of the bucket, the steam is condensed and the air passes up around the valve and seat and is discharged immediately the valve opens. In time the steam in the bucket is replaced by water, then the bucket loses its buoyancy and sinks, opening the valve.

The trap continues to discharge as long as water enters the inlet. As soon as steam enters it forces the water from the bucket, which then becomes buoyant, closing the valve, and the cycle of operation is repeated. All the operating parts, including valve *B* and seat *C*, are readily accessible by removing the flanged cover *D*.

The trap is being made in five sizes with standard pipe connections ranging from ½ to 2 in., and based on 125 lb. operating pressure the capacities range from 800 lb. for the ½-in. trap to 12,000 lb. for the 2-in. trap.

A line of complete forged-steel units in the 20 Series for high pressures and temperatures is now in course of development.

Improved Open-Type Feed-Water Heater

AN IMPROVED line of open feed-water heaters in capacities up to 70,000 lb. of water per hour, embodying important features, is announced by the Worthington Pump & Machinery Corporation, Harrison, N. J. The features include a combined ribbed and multiple baffle oil separator, new type of tray designed to break up the water into a finely divided state, and a two-way filter for the removal of precipitates.

Upon entering the heater the exhaust steam, after dividing and passing through the oil separator *A*, passes down the two side steam aisles to the bottom of the tray nest before it enters the heater proper. Here it fills the entire space and flows upward through special steam lanes.

Heater trays or pans *B*, of an entirely new design, are used. They are especially designed to divide the water into minute drops so as to expose a maximum total heat-absorbing surface to the steam. The curvatures are so proportioned that the water leaves the down-turned serrated edge of the pans in a finely divided state. The trays have been designed with a view to overcoming the trouble usually encountered from deposits of scale changing the water distribution within the heater. With the new tray, it is claimed, scale-forming matter simply causes the pan serrations to elongate and the actual distribution of the water is not appreciably affected.

Heated water from the pans flows directly into the water storage space *C* immediately over the filter. A large part of the precipitates, which have not collected on the pans, are deposited upon the filter covers *D*. The finer precipitates pass with the water, through the large port *E* at the side to a space *F* under the filter. Here additional precipitates are deposited. The water then passes upward through one side of the filter and downward through the other side, as indicated by the arrows into the pump suction chamber. Blow-off connections are provided so that the precipitates may be blown from the various compartments. The filtering compartment may be cleaned and the filtering material removed through flanged openings on the side and front of the heater.

Cutaway view of the open heater

An overflow trap of the float-controlled type (shown on the same side as the steam inlet) permits the use

of the heater under either atmospheric or back-pressure exhaust service. A deaerating heater type N-D embodying the same general design is also included in the new line.

Steam-Flow Meter

SIMPLICITY of design is an important feature of the velocity-type steam-flow meter illustrated, recently developed by the Foxboro Company, Foxboro, Mass.

The meter consists essentially of two mercury chambers connected by a "U" leg and the necessary indicating and recording mechanism. Each chamber is connected to the pipe line on either side of an orifice and the instrument interprets differential pressure or pressure drop across the orifice, in terms of pounds per hour flowing through the pipe line. Any change in the differential pressures at the orifice caused by a change in the rate of flow causes the mercury in the chamber *A* to move up or down. The steel float *B* moves with it and transfers the motion of the pen arm by means of a shaft and quadrant, as illustrated in Fig. 2. The pen is also connected with an integrator to give

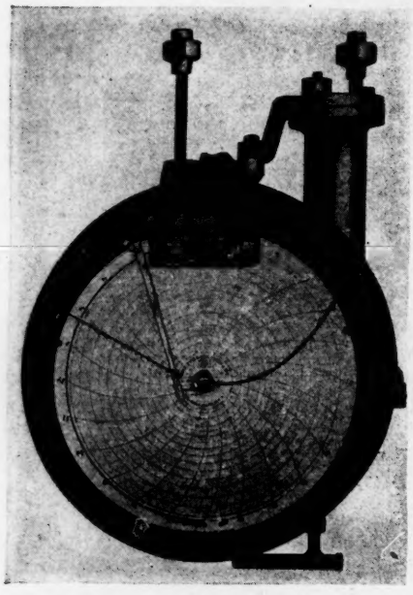


Fig. 1—Flow-meter assembly

totalization of flow, the counter of the integrator being mounted at the top of the meter. The integrator is operated by a Warren motor, or in some cases by a spring-wound clock, and once each minute it turns the shaft of the mechanical counter a fraction of a turn, the amount depending on the rate of flow. The chart graduations are so arranged that the flow of steam can be read directly from the face of the chart.

The meter can, if necessary, be adapted to a different type of service from that for which it was originally intended or the range can be changed, for instance, from 0-5,000 to 0-100,000 by the use of a new integrator gear and a new chart. A new nameplate is also supplied with the new integrator gear, showing the correct number of zeros after the integrator counter number. The meter is adapted also to installation below or above the level of pipe lines to which it is connected, a position below the pipe line being prefer-

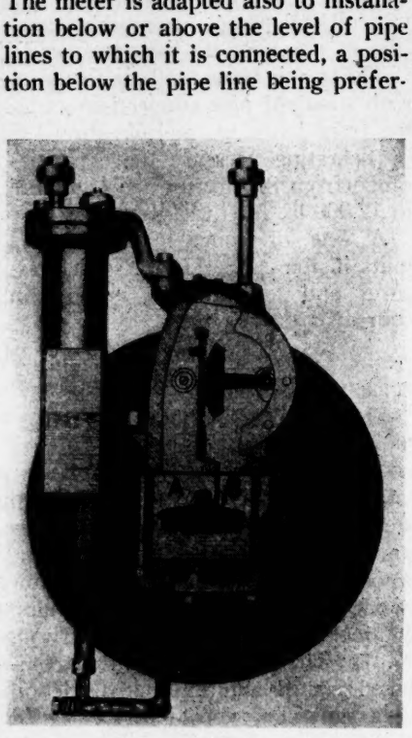


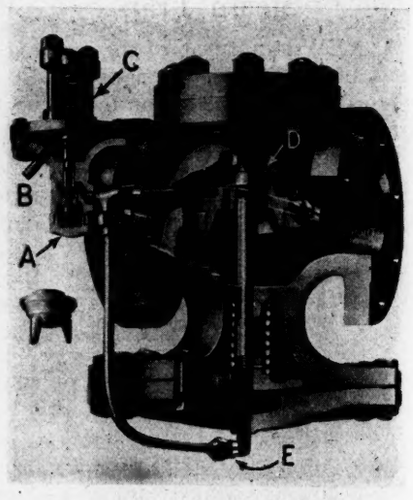
Fig. 2—Section through mercury chambers

able. When placed above the pipe line, it is necessary to follow certain arrangements recommended by the manufacturer.

Improved Pressure Regulator

AN IMPROVED model of the type ED pressure regulator put out by the Spence Engineering Company, Inc., 110 East 42nd St., New York City, is illustrated. It is built in sizes ¼- to 12-in. for use on air, steam, oil and gases, with pressures up to 400 lb. and temperature of 750 deg. It is designed to be equally applicable to heating systems, power-plant operation and manufacturing processes.

One of the important claims made for the improved regulator is its ability to give constant delivery pressure regardless of the fluctuations in the initial pressure. Under normal conditions the delivery pressure does not vary more than one-half pound and the initial pressure can drop to within one pound of the



Cutaway view of improved regulator

discharge pressure without affecting the pressure on that side of the valve.

In the improved model an auxiliary or pilot valve separate from the main valve, is retained as the master control for the regulator. The use of a separate pilot valve, as at *A*, allows the main valve to be of much simpler construction than would otherwise be possible, and the pilot is more readily accessible for inspection and repairs than when it forms an integral part of the main valve.

Large-diameter, balanced metal diaphragms and seats of special metal (Seco) with renewable disks are used. The seat and disk of the main valve or pilot can be reground or other working parts removed without taking the valve out of the line.

In operation the main valve *D* is normally closed. The delivery pressure is connected to the underside of the pilot diaphragm at the point *B*. When the pressure drops in the delivery line, the spring *C* forces the pilot valve open. This allows steam from the high-pressure side of the main valve to flow past the pilot faster than it can escape through the bleed port shown, causing an increase in pressure on the under side of the main-valve diaphragm, which in turn causes the main valve *D* to open. Then, when the pressure builds up, the pilot closes, allowing the higher

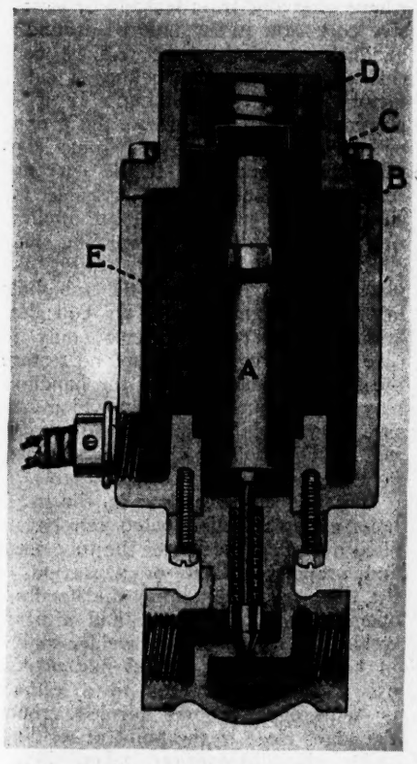
pressure to escape through the bleed port, and the main valve closes. The restriction fitting *E* retards the flow into the main-valve diaphragm chamber so that the valve moves slowly. This tends to eliminate pulsations and hold the delivery pressure steady.

For pressures up to 250 lb. and 450 deg. temperature the regulators are furnished with cast-iron bodies, and for pressures up to 400 lb. and 750 deg., with cast-steel bodies. Screwed ends are furnished up to 2-in. sizes and standard, extra-heavy or 400-lb. flanges above 2-in. All regulators are furnished with chromium-steel seats, and in sizes up to 3-in. with renewable disks; above 3-in., all metal disks are standard.

Packless-Type Solenoid Valves for Various Service

THE absence of a stuffing box on the valve spindle and the use of a sealed sleeve to protect the magnet coil are important features of the solenoid-operated valve illustrated.

The valve, which is designed for use on oil, water, gas, brine and air,



Cross-section of needle-type valve and operating solenoid

is made in four models, the principal difference in the various models being the design of the valve disk and seat to meet the requirements of the various services. The types include: type N, with needle valve in sizes from ¼ to ½ in., especially designed to control the feed supply to oil-burning equipment, water supply on refrigerating machines and similar services; type D, in sizes ¼- to 3-in., with globe valve of removable disk type; type SB, with semi-balanced valve in sizes from ½- to 3-in.; and type P, with piston valve in pipe sizes from 1- to 3-in.

All the solenoid movements for the several valves are of the same design, but to provide ample power to operate certain of the valves under various conditions and pressures, four sizes of solenoid movements are available.

Referring to the illustration, the movement is so constructed that the rust-proof steel plunger *A*, which is directly connected to the stem of the valve, is free to slide in the airtight housing *B* made of a special composition. This housing is sealed at the bottom by a gasket and at the top by a steel cap *C* which is forced down by the compression spring *D*.

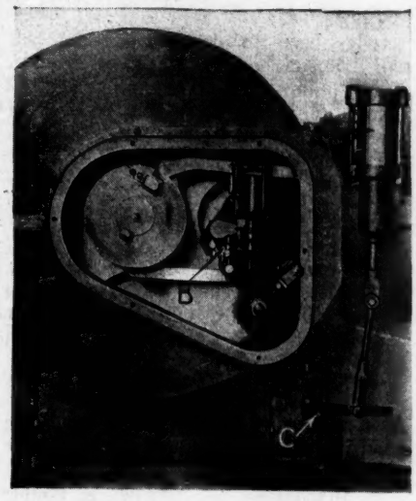
The use of the spring allows for expansion of the cast-iron housing owing to a rise in temperature of the solenoid under operating conditions and to conduction of heat from the valve body. The fluid to be controlled is allowed to flow into the plunger chamber, but is sealed from the coil by the sleeve *B*.

In operation, when the circuit is closed, the magnet is energized, lifting the plunger *A* to open the valve, in which position it is retained as long as the coil remains energized. Opening of the circuit or failure of the current causes the valve to close, and as the valves close with the flow, tight seating is assumed. The valve is actuated for remote control by push button, or automatically by means of a two-wire thermostat pressure regulator or float switch. When it is desired to have the valves operated automatically, a suitable relay is interposed between the control device and the solenoid valve.

In the model D valve, which is is fitted with a removable disk, either hard or soft disks made of various compositions can be used according to the nature of the fluid to be controlled. The SB valve is of the semi-balanced type with a double bevel disk, and can be furnished normally open or normally closed. The piston valve, type P, is designed especially for use with water, oil or brine for high pressure and for gas on low pressure. The Electric Valve Manufacturing Company, 68 Murray St., New York, is the manufacturer.

New Automatic Control for Stoker Drive

A SPECIAL device for automatically controlling the air and fuel supply, when using the new "Riflex" mechanical drive recently developed for Jones Stokers, is an-



Arrangement of the automatic control on the stoker drive

nounced by the Riley Stoker Corporation, Worcester, Mass This control consists of a master valve, which may be located at any convenient place in the boiler room, connected by a quarter-inch pipe to a small hydraulic power cylinder on the stoker drive.

A master control valve, which is hooked up to the boiler pressure, is actuated by a decrease or increase in the boiler pressure. This valve in turn controls the position of the piston in the cylinder *A*, and the position of the piston controls the rate of coal feed and air supply through its connections to the automatic device *B* of the "Riflex" drive and the shaft *C* of the damper in the air duct connecting the forced-draft fan and the stoker.

As the coal feed and air supply are tied together, a definite ratio of air and coal is maintained at all loads. As the steam pressure decreases or increases, the piston of the power cylinder moves up or down an amount necessary to feed the right quantity of coal and air to maintain an even pressure at all ratings that might be required from the stoker.

The "Riflex" mechanical drive, with which this control is used, was described in the Nov. 20, 1928, number of *Power*, consequently it will not be discussed.

FROM AMONG THE READERS'

Conducted
By
L. H. Morrison

Width of Belting. — *Is there a handy rule that can be used to determine the proper width of a single leather belt, without the use of much mathematics?* J.M.P.

It has been found that a one-inch belt will transmit one horsepower from a 30-in. pulley that is running at 100 r.p.m. This gives a belt tension of approximately 40 lb. per inch.

To find the horsepower of any other width, use the ratio

$$\frac{dia. \times r.p.m.}{30 \times 100} \times width = hp.$$

For example, if the pulley is 42 in. in diameter and runs at 200 r.p.m., to deliver 30 hp. we must have a belt width that will satisfy the equation $\frac{42 \times 200}{30 \times 100} \times W = 30$, or $W = 10+$ inch.

As a matter of precaution, it would be good judgment to use a 12-in. belt if the pulley is wide enough.

If the pulley is narrow, a double leather belt can be used. Its capacity is about 1.8 times that of the single leather belt, so that instead of a 12-in., a 6- or 7-in. belt would be ample.

Two-Phase and Three-Phase Power from the Same Transformer.—*Fig. 1 shows one of our transformer banks, as it is now connected. The bank gives a balanced two-phase and three-phase voltage on the secondary side of 230 volts, from a 2,300-volt three-phase primary. I should like to change the connections so that transformers A and C are grouped in a Scott connection to obtain two-phase power, instead of transformers B and C, Fig. 1. I should like to make the connection so as to obtain the same direction of phase rotation with the new grouping as with the old. Indicate on the diagram the direction of current flow. For an open-delta connection most diagrams show the two adjacent terminals connected together. As the transformers are now connected A and C are grouped in open-delta by connecting leads A' and C' to the same line. Does it make any difference which two leads are connected to the common line?* C. F. C.

The diagram Fig. 2 shows the connections changed to obtain two-phase power from transformers *A* and *C*. The arrowheads indicate the flow of current, for a given instant, in the various circuits. It will be seen that the current's direction is the same in both diagrams. It is not advisable to depend on this entirely for the phase rotation. Even if the diagram is correct, there is always the possibility of a mistake being made in connecting up the transformers, therefore it is advisable to make a test for phase rotation on the lines after the connections have been changed. This can be done by checking the rotation of a polyphase motor on the system, before and after the connections have been made. The motor should rotate in the same direction in both cases. If a phase-rotation indicator is available, it may be used instead of the motor. A test should be made on both the three-phase and the two-phase systems, if they supply power equipment.

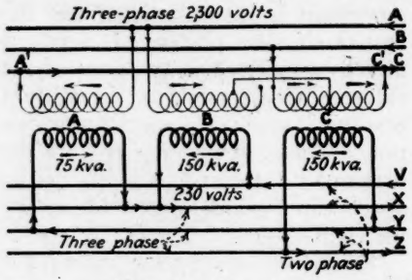


Fig. 1—Three transformers connected to supply two-phase and three-phase power

To make the change suggested it will be necessary to bring out a tap on transformer *A* that will include 87 per cent of the winding. This tap may not be easily made without dismantling the transformer, and it may be advisable to take the question of making the change up with the transformer manufacturer.

For an open-delta connection any one lead on each of the transformers may be connected together and to the common line. Leads in the same relative position should be used on both the primary and secondary. That is, if the two right-hand leads are used on the primary, then on the secondary the two right-hand leads should also be connected together. It is possible to obtain a voltage across the two transformers, equal to 1.732 times that on one transformer if the correct relation between the primary and secondary leads is not maintained.

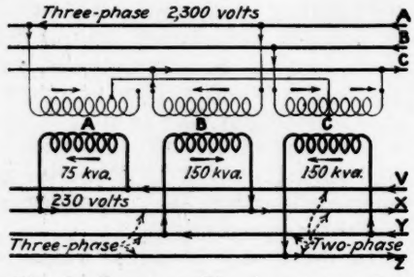


Fig. 2—Same as Fig. 1, except transformers A and C supply the two-phase power

Leaky Handhole. — *Many low-pressure, steel heating boilers of the horizontal portable type were made with a 4x6-in. handhole in the rear head below the tubes. The handholes were flanged in the head and small leaks through a defective gasket form a corrosive mixturee with the sulphur in the soot, eating holes through the curved portion of the flange. In many cases the distance from the upper side of the handhole opening to the lower side of the nearest tube hole in the sheet is less than one inch.*

I have tried gas welding, both by attempting to build up new metal to fill the holes and retaining the old handhole, and also by attempting to weld a flat steel plate over the handhole. In every case cracks appeared from the handhole to the nearest tube and any attempt to weld them made matters worse.

Can welding be used successfully? H.C.R.

C. W. Obert, Linde Air Products Company, was consulted regarding this, as he is secretary of the A.S.M.E. Boiler Code Committee. He states that where grooving from leakage or excessive corrosion is encountered around a handhole opening, there will be considerable difficulty in making a satisfactory repair by welding. If it is physically possible to do so, the groove or hole should be filled with some iron-cement compound, or if the corroded surfaces are sufficiently accessible for cleaning and preparation, an application of brazing or arc-welding may effect the repair without heating the plate enough to disturb the tube-hole bridges, or ligaments. This consideration would apply, however, only in case it is desired to build up and restore the gasket surface so that the handhole may be continued in use, in which case the general application of fusion welding would probably not be advisable unless expert welders are obtainable.

If it is decided to close up the handhole, either a bolted patch can be applied over that portion of the tube sheet and properly calked, or a section of the tube sheet containing the handhole opening may be cut out and a patch welded in its place. A welder skilled in boiler repairing would undoubtedly use a patch hammered to a camber or with ogee grooves formed around the edges close to the point of welding. With this precaution taken before welding, the patch will be found to have sufficient "give," or spring, to adjust itself to the contraction of the plate in cooling and thereby greatly reduce the strain that would otherwise be caused in the section of the plate containing the tube holes.

The use of a bolted cover plate will, in most cases, be more feasible.

PROBLEMS

ANSWERS

from Our Readers

THE QUESTION

WHEN an industrial plant load fluctuates widely by reason of steam-hammer operation, does pulverized-coal equipment work out more or less satisfactorily than do stokers? R. P. P.

PULVERIZED COAL equipment is more adaptable to widely fluctuating loads, for the coal and air can be increased or decreased more readily than with stokers. In fact, the response is almost instantaneous, provided the installation has been made properly and kept in good condition.

In plants burning coal that has wide variations in moisture, some method should be used in drying the fuel before entering the pulverizer, or heated air should be admitted to the pulverizer. Without some method of drying the coal it is difficult to meet wide fluctuations in load when the moisture content of the coal is high. C. J. HERBECK.
Cedar Rapids, Iowa.

A CORRECTLY designed and properly operated pulverized-coal plant operating under a widely fluctuating load should prove more satisfactory and show a somewhat higher over-all efficiency than a stoker-fired plant.

The advantages to be obtained with powdered fuel include the positive control of the fuel and air supplies to meet the load fluctuations. A heavy overload can be quickly taken on or dropped off without the loss of fuel that can rarely be avoided under like conditions with stoker firing. During banked periods the flow of fuel and air is shut off so that no fuel is consumed.

Cheaper grades of fuel may be utilized in the powdered state. Grades of coal that can be handled with very little success on stokers, are burned efficiently when powdered.

Over-all efficiencies of stoker-fired plants will decrease with a decrease in heat value of the fuel. Such is not the case with the pulverized system.

Loss of combustible in the ashpit is practically eliminated with powdered coal, and complete combustion is obtained with the minimum of excess air.

Progress in the development of unit pulverizers, short-flame burners and air-cooled walls makes possible the design of powdered-fuel plants of moderate size to compare favorably with stoker-fired plants as to first cost.

Maintenance cost of the equipment and furnace refractories should not exceed that of the stoker, coal- and ash-handling equipment and the brickwork of an equivalent size stoker-fired installation.

Operating labor in a pulverized-coal plant should be less than in a stoker-fired plant. EUGENE OGDEN.
Jeffersonville, Ind.

MORE satisfactory results and greater efficiency can be obtained from pulverized fuel. There is no incandescent fuel accumulation at a time when the steam pressure is rising fast owing to a large load decrease, as is the case with stokers.

Losses due to popping safety valves and excessive smoke are at a minimum.

The chief engineer of one of the foremost power plants takes great pleasure in demonstrating to visitors how the rating on a 20,000-sq.ft. boiler can be decreased from 200 to 25 per cent and increased to 200 per cent again in two minutes. P. A. SINTNER.
Milwaukee, Wis.

VARIABLE loads can be handled much more quickly by pulverized coal. Powdered coal does away with banked fires, reduces cost of labor, and any grade of coal can be used.

This system permits boilers to be operated at a high rating and the coal is burned with less waste, for it does not lie in a fire bed on a grate where sufficient oxygen cannot reach the combustible. In fact, so complete is the combustion that the boiler fires yield practically no smoke. In some instances, by using pulverizers the cost of coal has been greatly reduced. With stokers a coarser grade of coal has to be used, so that all the carbon lying in the coal is not burned as it is with pulverized coal. Maintenance costs are lower in pulverized-coal plants. W. S. EVERHAM.
Norwich, N. Y.

THE question cannot be answered categorically. In one plant pulverized coal may be more suitable, while across the street best results are obtained with stokers.

What this particular plant needs is more water capacity in the boilers, so that the sudden demands can be taken care of; I suggest that horizontal return-tube boilers be installed, with either stokers or pulverized-coal burners, or as second choice that a Ruths accumulator be added to the existing boiler installation.

No small drum-boiler can hope to cope with a rapidly varying load regardless of the kind of firing methods, with any degree of efficiency.
New York City. JOHN LYNCH.

THE chief advantages of powdered coal lie in the great flexibility, the high efficiencies that it is possible to maintain and in the wide range of fuels that may be used successfully.

Combustion with pulverized fuel is practically complete with only small amounts of excess air. With excess air maintained at 15 to 25 per cent, it is possible to have only a trace of carbon monoxide in the flue gases and still leave less carbon in the ash than is ordinarily possible with mechanical stokers.

The pulverized-coal equipment works out more satisfactorily than do stokers when required to meet fluctuating plant loads. The flexibility and zero stand-by loss cannot be obtained with any other type of coal-firing equipment.

All the powdered-coal preparation and feeding equiment is outside the furnace, and in case of a mechanical breakdown it is not necessary to let the furnace cool down before making repairs. Close regulation of the desired rate of combustion is more quickly and easily made than with a mechanical stoker, and fluctuating loads are readily maintained with practically no loss of coal as compared with stokers.
Newark, N. J. P. DIAS.

A Question For Our Readers

AT what boiler pressure does the usual glass gage prove unsatisfactory?

Suitable answers from readers will be paid for and published in the June 25 issue.

Rochester Meeting A. S. M. E.

Refractories, heat transmission and heat recovery were the topics dominating the program of the Rochester meeting of the American Society of Mechanical Engineers last week, May 13 to 16. Among several other subjects discussed, boiler feed water treatment and air preheaters held interest for the power engineer.

THE meeting was attended by about five hundred, and the local committee provided an interesting program of plant visits and entertainment. Among the plants inspected were the Garlock Packing Company, the Eastman Kodak Company, Bausch & Lomb Optical Company, Gleason Works, Stromberg-Carlson Telephone Manufacturing Company and the Taylor Instrument Companies. A reception at the home of Miss Kate Gleason and a banquet on Tuesday evening were the outstanding social events. The principal speaker at the banquet was Dr. C. E. K. Mees, Director of Research, Eastman Kodak Company, who in discussing "What Really Matters," drew examples from history of happenings which at the time were apparently insignificant yet had exerted a predominating influence on civilization. These he contrasted with happenings which attracted great attention at the moment but which proved of no consequence when measured in their effect on human progress.

Symposium on Boiler Furnace Refractories

Six papers made up this symposium at the first session of the meeting. They were: "A Laboratory Slagging Test for Boiler Furnace Refractories," by R. K. Hursh, University of Illinois; "A Study of Crystalline Compounds Formed in Slags on Boiler-Furnace Refractories," by T. A. Klinefelter and E. P. Rexford of the United States Bureau of Standards; "A Study of Some Factors in the Removal of Ash as Molten Slag from Powdered-Coal Furnaces," by Ralph A. Sherman, P. Nicholls and Edmund Taylor, all of the Bureau of Mines; "Evolution of the Slag-Tap Furnace at the Charles R. Huntley Station of the Buffalo General Electric Co.," by H. M. Cushing, chief engineer of that company; "Present Status of Tests for Refractories," by S. M. Phelps, Mellon Institute of Industrial Research, and J. S. McDowell, Harbison-Walker Refractories Company; and "Proprietary Air-Cooled Refractory Walls," by C. S. Gladden, General Motors Corporation.

Descriptions of the slagging type of furnace, as employed at the Charles R. Huntley Station, Buffalo, and the method of sluicing the slag have appeared in previous papers by the author and in articles in *Power*.[1] In the present paper Mr. Cushing told of conditions that led to its adoption and experiences gained with the earlier furnaces that have influenced the later designs. There are now fourteen of these furnaces in daily operation at this station and twenty more are in the process of building.

[1]See *Power*, Nov. 22, 1927, and May 1, 1928.

Pulverized coal was chosen for the 1926 extension because of the greater capacities demanded and the belief that boilers so fired could be made to respond more readily to sudden changes in load incident to peak-load stand-by operation.

With the usual type refractory-lined furnaces the engineer is forced to burn a high fusion-ash coal if he is to operate at high ratings with maximum efficiency; that is, with minimum excess air and must control the temperature so that the ash is thrown down in dry form. Much of the coal that comes into the Buffalo market has a relatively low fusion temperature, 1,800 to 2,300 deg. F., and a heating value of about 12,500 B.t.u. The slagging furnace of the well type made it possible to utilize such coal under high rates of forcing with minimum excess air and a relatively flat efficiency curve.

In the first furnace at high ratings 77,800 B.t.u. per cubic foot was liberated and over a million B.t.u. per cubic foot of the well below the burners. These extremely high values were obtained as a result of a desire to find the limit of punishment the materials would stand. For the next three boilers a furnace volume was chosen such that the heat liberation below the top of the burners was 234,000 B.t.u. per cu.ft. and for the total furnace volume 37,100 B.t.u. per cu.ft. These figures were slightly increased for the four 1928 boilers, which are designed for a steam output of 330,000 lb. per hour per unit.

The bottom of the well is made up of steel plates resting upon I-beams over a plenum chamber, and upon the plates are three layers of a good grade of firebrick which is also corbled up around the edges to form a basin. About six inches of burned dolomite is then spread over the firebrick, although on the last furnace built slag from one of the other furnaces was used instead of the dolomite with equally good results.

The water-cooled refractory lined walls that live under this service do so by virtue of the fact that the surface of the wall is maintained below the freezing point of the ash by its heat-conducting qualities, which carry the heat away from the surface exposed to the fire so fast into the water inside of the tubes that the wall-surface temperature is always kept below the ash-fusion temperature. This causes a layer of frozen ash to form over the wall, protecting it against further action of the slag and providing a self-renewing surface for the slag to flow over.

In discussing Mr. Cushing's paper, H. W. Brooks pointed out that this station is an outstanding example of dollar efficiency. The initial cost per kilowatt was little more than half the average for nine recently built central stations and the operating performance was within 2,000 B.t.u. per kilowatt-hour of the most efficient station in the country, which had a unit initial cost 2¼ times that of the Huntley Station.

Investigations at Toronto

The second paper on the "Removal of Ash as Molten Slag from Powdered-Coal Furnaces," by Messrs. Sherman, Nicholls and Taylor, was based on studies made at the Toronto, Ohio, station when burning three coals whose ash had fluid temperatures of 2,400, 2,600 and 2,800 deg. F., in a slagging furnace having horizontal burners and bare water walls on three sides. It was found that although the cone test and the chemical analysis are in a sense measures of the properties of a coal ash, the temperature of the slag must be higher than that at which it will just flow, as indicated by the cone test, so that the loss of heat at the walls, at the top hole and in the spout will not cause freezing. The investigation was directed at determining the relation between the composition and characteristics of the coal ash, the slag from the hearth and the dust carried out of the furnace. The results are given in the table.

Some of the observations are as follows:

The softening temperatures of the slags were lower than those of the original ash, but the fluid temperature did not decrease as much; the decrease of these fusion temperatures increased as those of the original ash increased and was about 120 deg. for the fluid temperature of the Georges Creek ash.

The percentage of the total ash fired which passed to the stack with the slagging-bottom furnace increased with increase in fluid temperature of the original ash. The amount carried out of the furnace even at the highest rating and with the least fluid ash was less than 50 per cent of that fired.

For similar coals the percentage of

ash which passed to the stack with the slagging-bottom furnace was approximately one-third less than with the dry-bottom furnace.

The slag from the molten bed would be expected to contain little combustible; as high as 8 per cent combustible was found in some samples.

Comparisons of the temperature of the gas below the boiler tubes in two furnaces exactly alike, except that one was equipped with a water-tube slag screen and ash-collecting hopper and the other with a slagging bottom installed above the slag-screen tubes, showed that the temperature, at similar boiler loads and excess air, was 300 to 400 deg. higher in the furnace with the slagging bottom. The temperatures at the outlets of the air heater were, however, nearly the same.

The removal of the molten slag was successful when burning Pittsburgh coal in boiler No. 5, and the reasons for this, as compared with the non-success in No. 4, apart from the more favorable position of the tap hole, were probably that there was a somewhat higher average temperature of the slag and also that the average fluid temperature of the slag was about 100 deg. lower.

COMPOSITION AND SOFTENING TEMPERATURES OF COAL ASH, SLAG, AND DUST SAMPLES

Description	Per cent SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	Initial deform. temp., deg.	Softening temp., deg.	Fluid temp., deg.
Boiler No. 4								
Strip-mine coal								
Coal ash	46.3	24.4	23.8	1.7	0.8	2050	2180	2400
Slag from bed	47.4	22.2	28.0	1.5	0.4	2000	2080	2430
Dust below tubes	46.8	24.5	21.1	1.5	0.4	2080	2220	2450
Dust from stack	49.9	24.0	21.3	1.3	0.5	2070	2210	2470
Pittsburgh coal								
Coal ash	51.7	26.9	10.6	3.9	0.8	2320	2470	2640
Slag from bed	52.5	26.3	14.7	4.8	0.4	2130	2360	2630
Dust below tubes	50.5	28.2	9.8	4.3	0.4	2190	2320	2570
Dust from stack	54.1	28.0	9.8	4.4	0.6	2300	2410	2660
Georges Creek coal								
Coal ash	56.2	33.5	5.4	1.1	0.6	2600	2700	2790
Slag from bed	55.6	29.1	11.7	1.2	0.3	2180	2370	2670
Dust below tubes	54.7	30.3	8.2	1.0	0.5	2640	2720	2830
Dust from stack	56.0	31.9	6.8	0.8	0.6	2770	2800	2890
Boiler No. 5								
Pittsburgh coal								
Coal ash	53.6	30.5	7.0	5.2	1.0	2270	2370	2610
Coal ash	51.7	30.4	8.4	4.6	1.1	2200	2340	2520
Slag from bed	51.5	28.2	13.1	4.7	0.9	2250	2360	2480
Slag from bed	51.2	28.0	14.1	4.6	0.9	2090	2220	2490

A brief study of fluxes for Pittsburgh coal ash showed that the addition of ferric oxide in an amount of 10 per cent of the slag deposited should lower the fluid temperature so that it could be successfully tapped as molten slag from the furnace investigated.

In reply to a question of John Blizard, Mr. Sherman stated that there appeared to be a greater tendency to slag the tubes with the slagging type of furnace, but he believed that this could be kept down if the furnace were designed originally for slagging and not merely altered, as was the case at Toronto.

Testing Refractories

The need for improved tests and specifications was brought out in a paper on "Present Status of Tests for Refractories," by S. M. Phelps, Mellon Institute of Industrial Research, Pittsburgh, Pa., and J. S. McDowell, Harbison-Walker Refractories Company, Pittsburgh, Pa. Tests used are durability tests, which must be made in actual practice and suitability tests and control tests, made in the laboratory. Modern conditions of severe service call for improvsements in all of these. When service tests have indicated the best type of refractory for a given condition, specifications with reasonable limits and tolerances can be drafted. Such specifications, written with a broad understanding of the methods of testing and of the service requirements, will stimulate research and lead to more definite correlation of laboratory and service data.

Recent results obtained at the Columbus Branch, Bureau of Standards, were outlined in a paper entitled "A Study of Crystalline Compounds Formed in Slags on Boiler Refractories," by T. A. Klinefelter and E. P. Rexford. This paper was a progress report on work done to date. The work is not yet finished and therefore no conclusions were given. The authors hope, when their experiments are finished, to have developed data from which the behavior of coal-ash slags in contact with clay refractories at boiler furnace temperatures can be predicted when the approximate composition of the slag and the operating conditions are known.

R. K. Hursh, Department of Ceramic Engineering University of Illinois, Urbana, Ill., in a paper entitled "A Laboratory Slagging Test for Boiler-Furnace Refractories," described some results of tests carried out with the furnace described in Circular 17, University of Illinois Engineering Experiment Station. It will be recalled that this furnace consists of a cylindrical chamber lined with a ring of the brick being tested. While the furnace is rotated, powdered slags are fed through a stationary gas burner which heats it, impinging on the vertical faces of the test brick and flowing out through the bottom. Comparison of slag effects is made by the volume loss per unit area of the exposed surface of the refractories.

The paper describes tests made with five coals used in power plants where field tests were conducted. The erosive effect noted varied with the chemical composition and the fluidity of the slags at the furnace temperatures used (up to around 2,900 deg. F.). It depends on the viscosity of the slag and is in direct proportion to the furnace temperature. In general the tests show parallel results to those obtained in boiler furnace operations, when the conditions are approximately the same.

In discussion, R. A. Sherman, Bureau of Mines, Pittsburgh, Pa., stated that Hursh's results check operating experience closely. He also called attention to the fact that a few simple changes in boiler furnace design will often reduce boiler erosion greatly, without decrease in the efficiency of the burners.

Air-Cooled Walls

In his paper on "Proprietary Air-Cooled Refractory Walls," C. S. Gladden discussed the evolution of boiler furnaces and the increasing tendencies toward higher ratings which are accompanied by increased maintenance with refractories. He classified air-cooled refractory furnace walls into two groups, (a) those in which special refractory shapes are held in position and supported by structural steel and cast-iron members, and (b) those in which the refractory shapes are bonded to the main wall but not supported thereby. In the first group are the Detrick, the American, the Bigelow, the DeWolf, the McLeod & Henry and the Laclede-Christy walls, certain features of which he compared. In the second group he placed designs of the Drake Non-Clinkering Furnace Block Company, the Furnace Economy Company, Combustion Engineering Corporation, American Arch Company, the Bigelow-Liptak Company and McLeod & Henry Company. He cited operating results in Binghamton, where Detrick walls are in service without water cooling for normal ratings up to nearly 300 per cent and peaks as high as 425 per cent.

At this plant the average rate of heat liberation is 10,750 B.t.u. per cubic foot of furnace volume per hour and 16,190 B.t.u. at the peaks. The fusion temperature of the ash is 2,260 deg. F. and slagging of the side walls occurs if the CO_2 exceeds 14 per cent. Pulverized coal is used.

Instances of other makes of walls were cited with comparable results.

The author's conclusions were in part as follows:

If the furnace is to be stoker fired and is to be designed for a moderate maximum heat liberation of not more than 25,000 B.t.u. per cu.ft. of furnace volume per hour, air-cooled walls should prove satisfactory. If the maximum heat liberation is greater than 25,000 B.t.u. per cu.ft. per hour, then water-cooled bridge walls should be considered and a certain amount of water cooling of the side walls, depending on the maximum rate of combustion. The air, after passing through

the side-wall cooling ducts, should be returned to furnace for combustion, thus reducing the radiation losses.

When pulverized coal, natural gas, fuel oil, or kiln-dried wood refuse is to be burned, the problem is somewhat different. Lower rates of heat liberation per cubic foot of furnace, the length and form of the flame, the load factor of the boiler, the fusion temperature of the ash, and the design of the boiler with respect to the extent and position of radiant heating surface exposed to the furnace should be carefully studied. The furnace walls should have little, if any, water-cooling surface if the load factor is low and the boiler must be operated at times at low ratings. On the other hand, if a high load factor is possible and the boiler will at all times be operated at high ratings, more water cooling of the side walls is justified. In general the furnace for rates of heat liberation of less than 15,000 B.t.u. per cu.ft. per hour may be constructed with air-cooled side walls and ash hoppers, provided the furnace bottom is sufficiently depressed below the flame travel to prevent slagging of the ash. If the rate of heat liberation is between 15,000 and 20,000 B.t.u. per cu.ft. per hour a water screen in the furnace bottom and a certain amount of water cooling of one or more of the side walls is advisable. If the rate of combustion liberates more than 20,000 B.t.u. per cu.ft. per hour, a still greater amount of radiant heating surface in the side walls is necessary.

In the discussion of Mr. Gladden's paper it was pointed out that all the heat recovered in air-cooled walls does not represent a gain as is the case with heat taken out of the waste gases by an air preheater; also that a high load factor may warrant the additional cost of a water-wall when the higher CO_2 obtainable over the longer period is considered. On the other hand, air-cooled walls can be repaired in a much shorter time than water-cooled walls, and this may be an important factor in the selection.

Boiler Feed Water Session

Calcium sulphate, in the anhydrite form, is the principal scale-forming material in boilers. For this reason particular interest attaches to the mechanism of its formation and to its thermal effect. These subjects were covered in a paper, "The Formation and Thermal Effects of Calcium Sulphate Boiler Scale," by Everett P. Partridge, associate editor, *Industrial and Engineering Chemistry*, and A. H. White, professor of chemical engineering, University of Michigan.

This paper was based on extensive work carried out in the laboratories of the University of Michigan. It established the fact that the initial deposition of calcium sulphate scale takes place as a result of the evolution of bubbles of steam or dissolved gas on the metal surfaces. Where the bubble edge has been in contact with the metal, a minute deposit of a crystalline nature is formed. The continued growth of these crystals is dependent on the fact that the solubility of calcium sulphate decreases with temperature increase. This explanation of scale formation supports Hall's theory, contradicts the colloidal theory, and provides a basis for the determination of scale-prevention methods.

Under ordinary conditions the effect of scale on heat utilization was stated as being slight. But with higher pressures and higher ratings in modern boilers, there is a narrower limit for the safe increase of tube temperatures. Thus the tendency toward local heating due to scale becomes more important. This applies particularly to tubes exposed to radiant heat.

The authors also found that scale will form regardless of the tube material and, hence, that no benefit, in so far as scale is concerned, is obtained from special tubes.

In discussion, Mr. Yoder, of the Cochrane Corporation, stated that he doubted whether the temperature difference was sufficient to cause the scale to grow. He suggested that rapid circulation of the water caused crystals to be thrown out and that scale grows from saturated solutions, due to circulation, upon the minute crystals deposited by gas bubbles.

R. E. Hall, of Hall Laboratories, Inc., said that scale is made up over crystals that grow over a long time and that circulation of water would not cause growth unless supersaturation was encountered. But in water where calcium sulphate scale is formed there is no free calcium sulphate present. In feed lines, where calcium carbonate scale is predominant, supersaturation is found because of the slow precipitation of the material and hence is the chief cause of the formation of this kind of scale.

S. T. Powell called attention to the fact that the paper was based on work done with pure solutions and did not take account of the effect of the presence of other salts.

In closing, Doctor Partridge said that scales, other than calcium sulphate, did not grow according to his theory. Scale formation may result from any cause that deposits small crystals on the surface and must grow from supersaturated solutions, though not by circulation.

Preventing Embrittlement

Embrittlement of boiler plate due to alkaline concentration in boiler waters has aroused much recent interest. F. G. Straub, University of Illinois, read a paper on "Control of Boiler Water Treatment to Prevent Embrittlement," which was therefore timely. He recommended a procedure for water analysis made necessary by the need for rapid and fairly accurate analyses that can be readily run by the boiler attendants. Those suggested are for total alkalinity, sodium sulphate and sodium phosphate. These analyses should be checked from time to time by competent laboratories.

Discussion, led by Dr. R. E. Hall, called attention to the work of Dr. J. R. McAdams, in which the phenomena attributed by others to caustic embrittlement, are stated to be due to corrosion-fatigue. This is a combination of corrosion with stresses of a cyclic nature, resulting in rapid failure of the metal. In any case high alkaline concentrations are a cause of corrosion and so are the cause of the failure, whether due to embrittlement or fatigue. A protective coating over the metal that will keep the alkaline materials out of contact, such as can be obtained by a proper use of phosphate in the feed water, avoids the caustic embrittlement or corrosion effect.

Power Transmission Economies

Great savings can be made in the average industrial plant by the proper selection, installation and care of machine drives. That this gain can be realized not only in purchasing and maintenance, but also in power requirements, was brought out by W. W. Nichols, vice-president of D. P. Brown & Company, in a paper entitled "Economies Which May Be Effected in Power Transmission." The results outlined are due to extensive testing of drives by means of a portable testing outfit consisting of a motor and a watt-hour meter.

An instance of power waste occurs where too high a belt tension is used, resulting in an undue friction load. Frequently, the size of motors used is based on the maximum load a machine is capable of handling, whereas the machine is never loaded so high and a smaller motor would have served. The large motor then operates at an inefficient point and with low power factor. This can be overcome by rigidly selecting the motor for the work that is to be done.

Another power waste occurs from the operation of machines too far below capacity, which causes an undue power charge per unit of output. A survey of user's buying habits showed that only a small number determine horsepower required by test. More extended use of such procedure would effect great savings. For instance, in one plant 235 tests on machines equipped with 2,100 hp. in drives reduced this amount by 1,100 hp. Some of the line-shafts in this test showed friction loads as high as 56 per cent.

In closing, the paper called attention to the savings that can often be made in power requirements by the use of group drive in place of individual motor drive.

Economizers and Preheaters

"The Design ond Proportioning of Economizers and Air Preheaters" was discussed by Hosea Webster, of the Babcock & Wilcox Company, who traced the evolution of operating practice through the last thirty years, during which period the rate of evaporation per square foot of boiler-heating surface and the rate of fuel burning per foot width of furnace have increased 1,000 per cent.

An input of 2½ to 3 million B.t.u. per hour per foot width of furnace is about the limit for a hand-fired stationary boiler. Underfeed and chain-grate stokers with forced blast can maintain an input of 20 million B.t.u. per hour per foot width of furnace, while recent designs of double ended pulverized-coal furnaces are being offered for as high as 35 million B.t.u. input per hour per foot width of furnace.

The introduction of pulverized coal requiring preheated air for proper combustion has greatly extended the use of air preheaters, of which three types are in use—tubular, plate and regenerative. The author showed slides of the principal makes in these three classes and explained their salient points. He stated that while the additional efficiency with economizers generally runs from 3 to 7 per cent, it runs from 5 to 10 and sometimes more where air preheaters are used. Service and operating conditions may warrant the use of either or both, each plant being an individual problem of station economies. The tables gives a comparative analysis of a number of typical combinations based upon their performance per foot width of furnace.

In the discussion W. F. Ryan brought up the question of cleaning preheaters and stated his experience at the Solvay plant where, after two years' operation, the original mill scale is on the plates and it has never been necessary to clean the preheaters. There is also a total absence of corrosion although the fans have become badly eroded from handling the gases laden with pulverized coal ash.

F. M. VanDeventer pointed out the importance of draft loss and those intangibles that cannot be given a money value in deciding whether or not to install preheaters.

Heat Transmission Session

"Heat Insulation Practice in the Modern Steam-Generating Plant" was the title of a paper by L. B. McMillan, consulting engineer, Johns-Manville Corporation, who outlined the engineering principles of heat-insulation design. Emphasis was given to the fact that the heat dissipated by so-called "radiation" losses is from the most valuable portion of the heat, and that these losses frequently result in the lowering of heat potential or temperature head, with a resulting loss in the value of all the heat as measured by its remaining effectiveness.

A distinction was drawn between the cost of average heat and the value of a particular portion of the heat in terms of what it will accomplish in the way of useful results. The higher value of high-potential heat was demonstrated, and a specific evaluation in the case of heat in superheated steam used for power generation showed that the high-potential increments of such heat may be 1½ or even 2 times as valuable as the average heat content of the steam.

The factors involved in determining the most economical thickness of insulation were discussed and a chart given on which each of the factors may be taken into account separately. The resulting economical thickness may quickly and conveniently be determined directly from the chart. A fuller abstract of this paper will appear in a later issue.

Percy Nicholls, of the United States Bureau of Mines, in discussing Mr. McMillan's paper, observed that if no factor of probability enters the case the computations as to economic thickness can be followed; but if uncertain factors such as availability of capital, cost of fuel and possible conditions several years hence are to be considered, it may become advisable to depart from the results of such computations and figure for a shorter period, say five years, which would indicate somewhat less insulation.

E. T. Cope, of the Detroit Edison Company, cited a check up that had been made between actual and calculated temperatures on a given length of large steam piping. This indicated that the radiation losses between bare and insulated pipe, when expressed in percentages, were not so great as might be expected. In reply to this Mr. McMillan pointed out that it is misleading to express such values in percentages of the heat in the steam; that, while the differences in percentages might be small the actual values might be large. The only criterion is the annual saving in dollars balanced against the cost of saving that small percentage. Moreover, savings effected through insulation are independent of other savings made through operation.

In the second paper of the Heat Transmission Session, R. H. Heilman, Senior Industrial Fellow, Mellon Institute of Industrial Research, described the methods employed and the results of investigations on the emissivity coefficients of various surfaces. Charts were constructed showing the heat loss by convection from different sized pipes and spheres and plane surfaces, as well as that lost through radiation. Relative emmissivity values for various surfaces, such as polished silver, lampblack asbestos paper, rough steel plate, polished brass, black laquer and white laquer, were also given and discussed.

Surges in Pump Discharge

Change from belt or other flexible connection to direct connection to heavy-duty oil engines has been followed by numerous cases of destructive failure in oil-pipeline pumps. These pumps of the duplex or triplex design, have been subjected to surges of pressure sufficient to cause rupture. Prof. H. Diederichs, of Cornell University, and W. D. Pomeroy, vice-president of Goulds Pump Company, Seneca Falls, N. Y., presented a paper entitled "The Occurrence and Elimination of Surge for Oscillating Pressures in Discharge Lines from Reciprocating Pumps."

This paper detailed experiments carried out at Seneca Falls, where conditions could be more exactly controlled than in the field, and deduced a theory from these tests. According to the conclusions reached, the cause of these failures was a series of pressure surges built up to dangerous heights, by the combined action of open-end and closed-end reflection of the pressure waves set up by impulses of the pump.

Two recommendations for eliminating these surges were given. The first of these consisted of establishing a correct relation between pump speed and length of discharge line. A chart for this relation was given. The second method involved the use of an air chamber, and designs of equipment for the purpose were discussed.

TABLE 1 SERVICE CONDITIONS AND PERFORMANCE CHARACTERISTICS OF PRESENT-DAY TYPICAL COMBINATIONS OF BOILER, ECONOMIZER, AND AIR HEATER PER FOOT WIDTH OF FURNACE

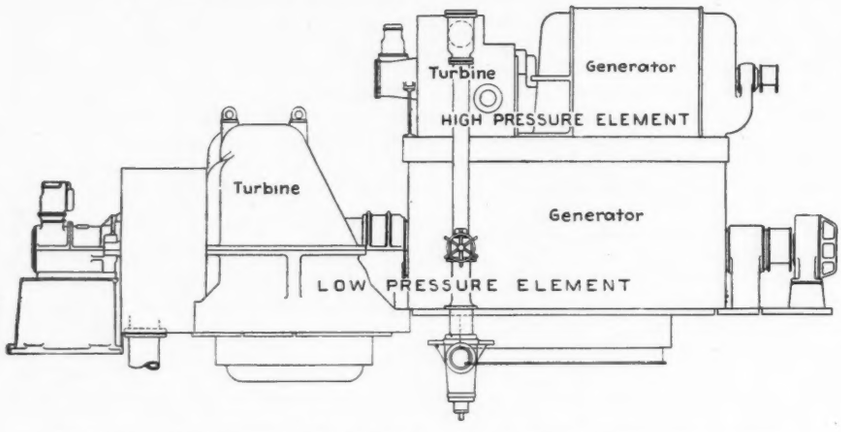
	1		2		3		4		5		6		7		8		9		10		11		12		13		14
Working pressure, lb.	200		200		200		200		325		350		350		400		400		475		500		1350*		285		350
Fuel and type of furnace†	Pulverized		Pulverized		Underfeed stoker		Underfeed stoker		Pulverized		Underfeed stoker		Chain-grate stoker		Underfeed stoker		Pulverized		Underfeed stoker		Pulverized		Pulverized		Pulverized		Oil
Per Foot Width of Furnace:																											
Boiler surface, sq. ft.	550		550		550		550		450		1000		810		880		1130		925		1350		275		1450		664
Economizer surface, sq. ft.	...		257.5		...		257.5		190		270		...		630		...		...		...		525		380		
Air heater surface, sq. ft.	800		...		800		..		420		1020		1610		...		1200		1130		2300		1220		1250		700
Output and Input:																											
Thousand lb. steam per hr.	2.55	5.60	2.55	5.60	2.55	5.60	2.55	5.60	2.0	4.0	8.3	15.5	3.0	12.0	2.0	9.0	3.5	10.0	5.75	17.25	11.5	20.0	3.35	8.00	4.75	25.5	2.7	12.65
Output million B.t.u. per hr.	2.77	6.50	2.77	6.50	2.77	6.50	2.77	6.50	2.2	4.5	9.6	18.15	2.35	9.40	3.3	10.4	4.1	11.7	6.7	16.00	12.0	24.5	3.35	8.90	7.60	26.5	2.95	13.3
Fuel input million B.t.u. per hr.	3.15	7.80	3.17	7.70	3.24	8.03	3.29	8.04	2.8	5.35	11 0	21.6	2.70	11.50	3.7	12.0	4.65	13.6	7.57	20.00	14.0	29.5	3.80	10.3	8.50	31.0	3.45	17.0
Lb. steam per hr. per sq. ft. of boiler	4.5	10.5	4.5	10.5	4.5	10.5	4.5	10.5	4.4	8.8	5.0	15.5	3.0	12.0	3.1	14.5	3.0	8.75	6.1	20.5	8.5	17.0	12.55	34.5	5.0	17.5	4.0	18.0
Draft Loss, In. H_2O:																											
Boiler	0.16	1.42	0.2	1.80	0.33	1.75	0.42	2.26	0.17	0.57	1.42	5.41	0.27	3.35	0.23	2.3	0.28	2.5	0.77	7.5	3.0	11.5	0.4	3.10	0.27	3.6	0.17	4.05
Economizer	...	...	0.31	1.90	...	...	0.52	2.39	0.10	0.35	0.52	1.96	...	...	0.18	1.8	...	...	0.60	5.85	...	...			0.35	4.7	...	...
Air heater	0.19	1.10	...	...	0.31	1.32	...	...	0.15	0.50	0.56	2.12	0.14	1.77	...	...	0.29	2.6	...	...	1.55	6.0	0.21	1.60	0.28	3.7	0.12	2.83
Total	0.35	2.52	0.5	3.70	0.64	3.07	0.94	4.65	0.42	1 42	2.50	9.49	0.41	5.12	0.41	4.1	0.57	5.1	1.37	13.35	4.55	17.5	0.61	4.70	0.90	12.0	0.29	6.85
Resistance through air heater, in. H_2O	0.14	0.22	..	..	0.29	1.25	..	..	0.13	0.45	1.71	6.50	0.15	1.85	..	..	0.32	2.8	0.67	5.70	1.05	4.0	0.21	1.60	0.16	2.10	0.13	3.19
Efficiencies:																											
Boiler	81.5	74.9	81.5	74.9	77.6	71.5	77.6	71.5	79.7	75.9	79.8	74.5	79.4	73.5	82.2	78.5	82.5	79.1	79.9	67.6	79.6	75.7	...	...	80.0	70.9	80.3	69.9
Boiler and economizer	...	...	87.2	83.9	...	...	84.2	80.8	83.6	80.4	82.8	80.2	...	...	88.9	85.7	...	...	...	...	...	...	82.7	78.7	85.2	79.7	...	...
Boiler and air heater	87.6	83.3	..	.	85.4	81.0	..	..	..	..	..	...	87 3	82.6	..	..	88.2	86.0	87 5	80.3	85.7	83.5	88.6	85.2	..	..	85.6	78.4
Boiler and economizer and air heater	..	..	..	..	..	..	..	..	87.5	84.8	87.5	85.1	..	...	..	..	..	..	..	...	..	.	..	..	88.8	84.7	..	...
Stack temperature, deg. fahr.	292	466	308	449	286	449	324	456	241	313	276	335	209	344	232	413	242	332	249	347	329	435	225	325	270	374	277	589

* Steaming economizer.
† Bituminous coal, cols. 1 to 13; oil, col. 14.

Events and Men in Power's Field

THE EDITORS WILL WELCOME THE CO-OPERATION OF READERS IN REPORTING INTERESTING HAPPENINGS, PERSONAL OR OTHERWISE

High-Pressure, Double-Deck, Compound Turbine-Generators Installed



Unique arrangement of high and low pressure elements saves space

SEVERAL unusual or new features will be incorporated in two steam-turbine generators which are to be added to the generating facilities of the Pacific Gas & Electric Company, San Francisco. The two machines, each rated at 50,000 kw., will be the first of the new double-deck compound type, will be the first 1,200-lb. units on the pacific coast, and will be fueled with natural gas piped from a source 240 miles away.

The station will be one of the most efficient in the world, the result of employing 1,250-lb. steam and using natural gas as fuel. Each main 1,200-lb. turbine unit, of General Electric manufacture, consists of a high-pressure element operating at 3,600 r.p.m. and a low-pressure element operating at 1,800 r.p.m. The turbines, rated at 50,000 kw. each, are to be suitable for a maximum output of 62,000 kw. Provision is made so that the low-pressure turbine can be operated from the high-pressure boilers with the high-pressure turbine shut down.

A new type of construction will be used, in that the high-pressure turbine and generator will be mounted on top of the low-pressure generator, thereby saving the foundation and the floor space ordinarily required for the high-pressure unit. The result is a very compact unit; and, since working out the design details, this type of construction appears even more advantageous than when first proposed.

In addition to the main turbines two auxiliary turbines are included for driving the boiler-feed pumps. These pumps, used with the high-pressure boilers, require considerable power, therefore their turbines are much larger than usual. They are of the two-unit type, composed of condensing and non-condensing elements. The condensing element is coupled to one end of the pump and takes steam from the present 300-lb. boilers, the non-condensing element is coupled to the other end of the pump, and takes steam from the cross-over between the main turbines. This arrangement permits the two elements of the turbine to be operated at times independently and at other times together, so as to maintain at all loads the most economical heat balance on the installation as a whole.

Survey Shows Significant Changes in Industrial Power

Increases in the installation of electric motors to supply power in manufacturing, in the amount of power purchased instead of generated by manufacturing plants, and in the efficiency of prime movers, are mentioned as significant changes in industrial power that have taken place in the last seven years, in the survey of the National Bureau of Economic Research which is to be published with the report of the Committee on Recent Economic Changes of the President's Unemployment Conference.

L. P. Alford, engineering authority and vice-president of the American Engineering Council, writing in one of the chapters of the survey under the title, "Technical Changes in Industry," gives as one of the reasons for the rapid development of electric utility companies the first two trends mentioned above and adds: "The increase in the capacity of prime movers which supply power to manufacturing establishments is a rough measure of the increased use of machinery in those establishments.

"The change whereby the total amount of owned power in manufacturing has decreased but slightly since 1919, and the purchased power supplied through electric motors has increased 12.7 per cent in the same period, indicates a shift that is often referred to as 'from a machine civilization created by steam to a machine civilization created by electric power.'

"The electric motor first appeared as a factor in industrial power in 1899, the amount of power purchased at that time and applied through electric motors being but 1.8 per cent. So rapid has been the increase, however, that in 1925, the last year for which we have statistics, nearly 45 per cent of the power applied in manufacture was by means of electric motors. It is probable that today the total is fully one half.

"Unfortunately," the writer continues, "not much can be said in regard to changes in efficiency as regards the prime movers in use in manufacturing plants. Where new power plants are

Men in the News

MARCUS T. LOTHROP

was elected president of The Timken Roller Bearing Company, of Canton, Ohio, at a meeting of the board of directors on May 7. He succeeds H. H. Timken, who becomes chairman of the board.

Mr. Lothrop started with the Timken company in 1911 as a metallurgist, and for the last eighteen years has been closely connected with its affairs. During that time he has occupied various positions successively in metallurgy, research and operation.

installed they make use of the most efficient equipment available. But many plants are old and are operating under disadvantageous conditions with low over-all efficiencies.

"For certain large industrial establishments where considerable process steam and power are needed, the tendency is toward higher boiler pressures with steam turbines as reducing valves, even with steam mains at more than one pressure intermediate of the boiler, as a maximum, and the lowest process pressure, which is the back pressure of the last turbine, as a maximum.

"Where process steam is not the determining factor and the demand is merely for mechanical power, the choice usually lies between either purchasing from a steam or hydro-electric station distributing system, or using oil engines."

High Pressures to Be Used in New Steam Locomotive

Steam pressures between 1,300 and 1,400 lb. will be used in an experimental, double-pressure steam locomotive to be built immediately for the New York Central Railroad. Of a type radically different from any yet seen in America, this locomotive will have compound engines with equalized outputs from the high- and low-pressure cylinders.

The steam generating system is divided into three parts. First of these parts are the water tubes around the sides and top of the firebox. These tubes are filled with distilled water and are sealed so that the water circulates within them only.

These water tubes extend upward into the second part, which is a forged nickel-steel drum outside of and on top of the boiler. Steam in the tubes at a pressure between 1,300 and 1,400 lb. gives up part of its heat to the water in this drum, which has no other connection with the firebox, thus generating steam at a pressure of 800 to 900 lb. in the drum.

Saturated steam from this high-pressure drum circulates through superheated coils in the flues of the boiler in the usual way and is then delivered to the high-pressure cylinders.

The third part of the steam generating system consists of the barrel of the familiar locomotive boiler. It generates steam at upward of 200 lb. pressure from the gases passing from the firebox through the flues. Steam from this low-pressure boiler is superheated, then mixed with exhaust from the high-pressure cylinders and supplied to the low-pressure cylinders. The arrangement of supply pipes and a mixing chamber for steam at different pressures obviates the common trouble in compound engines of unequal output of high- and low-pressure cylinders.

A feature of importance is the utilization of the low-pressure boiler as a feed-water purifier for the high-pressure generator, which will supply about 60 per cent of the steam used by high- and low-pressure cylinders.

Spot * News

EARLY REPORTS *of a complete failure of Detroit Edison service on May 10 proved to be exaggerated. Actually, bus trouble in an outdoor substation interrupted service for 30 minutes to a relatively small industrial area and caused half-voltage for 25 minutes to 18 wholesale customers. The Detroit direct-current system was down to 90 volts for three minutes. No other service was disturbed.*

* * *

THE BUSSEY *low-temperature carbonization plant at Glenboig, near Glasgow, Scotland, is expected to be in full operation before the end of this month. It has a capacity of 600 tons of coal a day.*

* * *

CENTRAL STATION *net output of electrical energy for New York City reached a new high total of 4,211,000,000 kw.-hr. in 1928. The figure is 11.6 per cent greater than that of 1927.*

* * *

THE LARGEST STEEL *drums in the world have just been constructed at the Atlas Steel Works in Sheffield, England, for experimental purposes. Their outside diameter measures 17 ft. 8 in. with a 5⅞-in. wall. They weigh 48 tons each.*

* * *

ERECTION *of a steam power plant at Glace Bay, Nova Scotia, to cost about $2,000,000, is planned by the British Empire Steel Corporation. The plant will furnish a much-needed market for Cape Breton coal.*

* * *

A DEMONSTRATION *meeting in the mechanical laboratories of the Massachusetts Institute of Technology, Cambridge, at which welded joints of all types will be tested to destruction, is planned for the fall by the Boston Section of the American Welding Society.*

* * *

MORE THAN *3,500 employees and executives of the electric light and power companies in Greater New York and Westchester County attended the sixth annual Safety Rally held on May 10, under the auspices of the N.E.L.A. Victor W. Galleth, an employee of the New York Edison Company, was awarded the Insull Medal at the meeting.*

* * *

A MERGER OF *the Utility Shares Corporation into the American Superpower Corporation has been voted by the boards of directors of both companies subject to the approval of stockholders.*

* * *

EIGHTY-THREE *light and power companies, with more than 1,000 employees each, have entered the 1929 safety contests which are being conducted by the National Safety Council. Trophies will be presented to the winners at the 18th Annual Safety Congress to be held in Chicago, Sept. 30 to Oct. 4.*

Heavy Rains Slightly Hinder Work on Gorgas Plant

Construction work on the Alabama Power Company's new steam plant at Gorgas was only slightly affected by the recent heavy rains which raised the stage of the Warrior River to fifteen feet above normal at one time. A small amount of extra work had to be done with the drag-line excavator when parts of the sandy banks of the condensing water canal caved in.

Four huge 23,333-kva. transformers for the plant arrived recently. Each weighed 82 tons and had to be shipped from the Sharon plant of the Westinghouse Electric & Manufacturing Company on a specially constructed low-slung car. These cars were routed so as to avoid all bridges and tunnels which, on inspection, were found to have inadequate clearance space.

The boilers for the Gorgas plant are said by the manufacturers, Babcock & Wilcox, to be the largest of the cross-drum type in the world. They have an effective heating surface of 30,320 sq.ft., and the drums are 72 in. in diameter. Each of them will deliver approximately 450,000 lb. of steam per hour at a pressure of 475 lb.

It is expected the plant will be in operation by the fall of this year.

New Power Plant for the Gulf Refining Company

A new power-plant development for the Port Arthur refinery of the Gulf Refining Company is being undertaken at present by the United Engineers & Constructors, Inc., of Philadelphia, Pa. The plant is to consist of three boilers, each having 15,000 sq.ft. of heating surface and an operating pressure of 535 lb. Superheaters and air heaters are included in the equipment to be installed. Both fuel oil and pulverized coke will be used to fire the boilers. This work also includes the installation of a 10,000-kw. turbine exhausting at 125 lb. back pressure, the steam to be used for process work.

Water Power Policies Committee Holds Meeting

Fundamental questions bearing upon the development and regulation of the nation's water powers were discussed at the third meeting of the Water Power Policies Committee of the Chamber of Commerce of the United States, held in Washington, May 3 and 4. The meeting was called for the purpose of discussing recommendations as to national policies, and much time was devoted to that end.

As a result of the factual studies which the Chamber had undertaken at its first meeting, a large amount of material relating to state regulation has been collected and studied. This material, together with the wide experience of several committee members in regulation matters, brought forth many ex-

pressions of views and some division of opinion on this important question.

A new subcommittee consisting of Dr. Thomas S. Baker, president, Carnegie Institute of Technology, Pittsburgh; Lewis B. Stillwell, consulting engineer, New York City; and Horace W. King, professor hydraulic engineering, University of Michigan, Ann Arbor, was appointed to make a study of the adequacy of basic water-power data, the extent to which the federal government and the states co-operate in carrying on investigations and to report upon the needs, if any, for making information more generally available.

Other subjects which, as a result of discussion, will be studied further are agreements between states in the form of compacts covering water power, administration of the Federal Water Power Act, and state agencies for dealing with water power, particularly as to their organization and methods.

Several of the existing sub-committees will meet before the summer vacations to draft their reports.

The committee adjourned to meet again in September, when it is contemplated that final recommendations will be prepared.

Permit Sought for Project at Priest Rapids, Wash.

Application has been filed by the Washington Irrigation & Development Company, Seattle, with the state hydraulics supervisor for permission to appropriate 50,000 sec.-ft. of water from the Columbia River in Grant and Yakima Counties, Wash.

Plans call for the erection of a 90-ft. dam and the creation of a reservoir with a storage capacity of 140,000 acre-ft., which would inundate 5,715 acres of land. The power plant would house two units with total capacity of 450,000 hp. The first unit, which would be undertaken within the next two years provided the permit was obtained, would have an output of 200,000 hp. The total cost of the entire project is estimated at $41,242,000.

Distance Kw.-Hr. Travels Is Decreasing

A review of the movement of electric power during the last few years indicates that the average distance traversed by the average kilowtt-hour in its path from power house to consumer in the United States is about 22 miles, according to the Statistical Research Department of the National Electric Light Association. If the production of the State of California, with its power plants for the most part in the Sierras and its use in the lowlands along the seacoast, is excluded, the average for the rest of the United States is only 18 miles. It would seem, therefore, that in spite of the extraordinary progress in the interconnection of electric light and power systems and the extension of transmission lines during recent years, the great bulk of electric energy is still consumed near the power plants.

Coming Conventions

American Boiler Manufacturers Association. Annual meeting, June 3-5, Sky Top Lodge, Cresco, Pa. A. C. Baker, secretary, 801 Rockefeller Blvd., Cleveland, O.

American Institute of Electrical Engineers, annual summer convention, Swampscott, Mass., June 24-28. Pacific Coast Regional Meeting, Santa Monica, Calif. Sept. 3-6. F. L. Hutchinson, secretary, 33 West 39th St., New York City.

American Society of Heating and Ventilating Engineers, annual summer meeting, Bigwin Inn, Lake of Bays, Ontario, Can., June 26-28. A. V. Hutchinson, secretary, 29 W. 39th St., New York City.

American Society of Mechanical Engineers, spring meeting, Salt Lake City, Utah, July 1-4, 1929. Calvin Rice, secretary, 29 West 39th St., New York City.

American Society of Refrigerating Engineers. Summer convention at Penn State College, State College, Pa., June 20-22. Secretary, W. H. Ross, 35 Warren St., New York City.

American Society for Testing Materials. Annual meeting, June 24-28, at Chalfonte-Haddon Hall, Atlantic City, N. J. Secretary, C. L. Warwick, 1315 Spruce St., Philadelphia, Pa.

Association of Iron and Steel Electrical Engineers, 25th annual convention, Pittsburgh, Pa., June 17-22, 1929. A. A. Stewart, secretary, Pittsburgh Steel Co., Monnessen, Pa.

Canadian Electrical Association, annual convention, to be held June 19-21, at St. Andrews-by-the-Sea, N. B. H. M. Lyster, secretary, Power Building, Montreal, Que.

Master Boiler Makers Association, at Atlanta, Ga., May 21-24. H. D. Vought, secretary, 26 Cortlandt St., New York City.

National Association of Power Engineers, 47th annual convention, Chattanooga, Tenn., Sept. 9-13. Fred Raven, secretary, 417 South Dearborn St., Chicago, Ill. N. J. State Association annual meeting, June 1-2, at Eagles Hall, Elizabeth, N. J. Conn. State Association annual meeting, June 14-15, at the Stratfield Hotel, Bridgeport, Conn. New England States Association annual meeting, June 20-21, at Fitchburg, Mass.

National Board of Boiler and Pressure Vessel Inspectors. Annual meeting, June 18-20, at Detroit, Mich. Secretary, C. O. Myers, 14 Commercial Nat'l Bank Bldg., Columbus, Ohio.

National Electric Light Association. Annual meeting at Atlantic City, N. J., June 3-7. A. J. Marshall, secretary, 420 Lexington Ave., New York City.

National Exposition of Power and Mechanical Engineering, Grand Central Palace, New York City, Dec. 2-7. Charles F. Roth, manager, Grand Central Palace, New York City.

National Oil and Gas Power Meeting. Under auspices of A.S.M.E. Oil and Gas Power Division and the Pennsylvania State College. June 24-27, State College, Pa. F. G. Hechler, chairman, State College, Pa.

Northwest Electric Light and Power Association. 22nd Annual Convention, June 26-29, 1929, at Seattle, Wash. Registration and information: J. J. Hayes, Westinghouse Electric & Manufacturing Company, Seattle, Wash.

Universal Craftsmen Council of Engineers. Annual meeting in Detroit, Mich., Aug. 6-10, at the Book-Cadillac Hotel. Grand Secretary, T. H. Jones, 33 Linden Ave., Cherrydale, Va.

World Engineering Conference, Tokyo, Japan, October, 1929. All correspondence should be addressed to the Secretary, World Engineering Conference, Nikon, Kogyo Club, Morunouchi, Tokyo.

Proposed Tariff Affects Rate on Generating Equipment

To correct the inequalities in the present tariff law governing the importation of electrical machinery and apparatus, the Ways and Means Committee of the House of Representatives, in the tariff bill introduced May 7, has set up new classifications governing these imports. In the present law, transformers, wiring devices and control apparatus are dutiable at 40 per cent ad valorem as manufactures of metal. Generators and motors, which are more expensive and more difficult to manufacture and which are subject to keen competition, are assessed only 30 per cent ad valorem as machines. In addition, the interpretation of the word "machine," as applied to electrical equipment, has resulted in transferring certain equipment to the basket clause of the metals schedule. In order to provide more adequately for electrical equipment and related articles, a new paragraph is proposed as follows:

"All articles suitable for producing, rectifying, modifying, controlling, or distributing electrical energy; electrical telegraph, telephone, signaling, radio, welding, ignition, wiring, therapeutic, and X-ray apparatus, instruments and devices; and articles having as an essential feature an electrical element or device, such as electric motors, fans, locomotives, portable tools, furnaces, heaters, ovens, ranges, washing machines, refrigerators and signs; all the foregoing and parts therefor, finished or unfinished, wholly or in chief value of metal and not specifically provided for, 40 per cent ad valorem."

OBITUARY

EUGENE H. ABADIE, consulting engineer, of Washington, D. C., was instantly killed April 27 in an automobile accident. He was born in Missouri and graduated from Washington University. In 1903 Mr. Abadie formed E. H. Abadie & Company, engineers and contractors. One of the outstanding pieces of work of this firm was the design and construction of a heating plant and power house for the State of Missouri at Jefferson City.

LEE H. HOOK, works manager of the Calumet Steel Company at Chicago Heights, Ill., for the last twenty years, died April 26 at the age of 51, following a long illness.

A. LEWIS JENKINS, professor of mechanical engineering at the University of Cincinnati, died March 8. The Cincinnati Section of the A.S.M.E. expressed an appreciation of his life and work at a recent meeting.

HERVEY N. SCOFIELD, manager of the New York Office of the American Engineering Company of Philadelphia, died May 11. He had been with the company eighteen years.

PERSONALS

WALTER C. LANGE, combustion engineer, who has been engaged in the fuel-economy and boiler-plant investigation and supervision field for the last ten years, has joined the New York firm of Sullivan & Hamilton, consulting engineers and specialists in industrial heat and power work.

W. R. HOLWAY, consulting engineer, New York, formerly consulting engineer to the Cuban government, left this country on April 24 for Moscow, Russia. He is to make a report on the proposed new water-supply system for that city.

W. J. ROBERTS, formerly of Tacoma, Wash., has been appointed chief engineer of the Centralia power project, hydro-electric power unit No. 1, which the city of Centralia, Wash., is building on the Nisqually River.

WILLIAM C. CLARK, formerly associated with J. F. Ancona, engineer of Rochester, N. Y., has opened his own office as consulting engineer in the Temple Building. Mr. Clark was formerly connected with the engineering firm of Lockwood, Greene & Company, of Boston, Mass.

BUSINESS NOTES

TRICO FUSE COMPANY, Milwaukee, Wis., has moved its New York division sales office to 41 Park Row, that city.

THE CHICAGO PUMP COMPANY has added W. T. Morgan to its organization. He was formerly with Gould's Pumps, Incorporated. He will serve as manager of engineering service in the company's New York office.

INDUSTRIAL BROWNHOIST CORPORATION of Cleveland has recently purchased the manufacturing operations and business of the McMyler Interstate Company of Bedford, Ohio.

W. B. RICHARDS & COMPANY, INC., formerly at 16 Exchange Place, New York City, have moved uptown to 545 Fifth Avenue.

LEEDS & NORTHRUP COMPANY is adding approximately 85,000 sq.ft. of floor space to its property by the construction of a new building.

PENNSYLVANIA PUMP & COMPRESSOR COMPANY has made Carpenter & Byrne, 4 Smithfield St., Pittsburgh, Pa., its sales representatives in the Pittsburgh district.

NORTH AMERICAN REFRACTORIES COMPANY, a consolidation of six manufacturers of firebrick and related products has set up its general offices in the National City Bank Building, Cleveland, Ohio. The organization controls fifteen plants with an annual production capacity of 155,000,000 units. J. D. Ramsay has been elected president; E. M. Weinfurtner, first vice-president; H. E. Stuhler, vice-president and treasurer, and E. W. Valensi, secretary.

THE JOHNS-MANVILLE CORPORATION announces the removal of its Western Division headquarters from S. Michigan Avenue and 18th Street to 230 No. Michigan Avenue, Chicago, Ill.

QUIGLEY FURNACE SPECIALTIES COMPANY has moved its main office from Cortlandt Street to new headquarters in the Lakner Building, 56 W. 45th Street, New York City.

THE BROWN INSTRUMENT COMPANY is again enlarging its Philadelphia plant at an approximate cost of $200,000. The new building and central wing, of which the Ballinger Company, of Philadelphia, are the architects and engineers, will increase the floor space about 50 per cent.

With the Society Sections

A. S. M. E., Colorado Section. All-day meeting at Boulder, May 23, to be known as "Engineers Day."

A. S. M. E., Kansas City Section. Annual banquet at the Ambassador Hotel, Kansas City, May 27 at 7 p.m. All visitors are cordially invited to attend.

A. S. M. E., Philadelphia Section. Meeting May 23 at the Penn. Athletic Club. Speaker, Dr. A. Ray Petty. There will also be a splendid surrounding program.

A. S. M. E., Worcester Section. Meeting May 28 at the Rolls Royce Chassis Works, Springfield at 2:30 p.m. Inspection trip followed by a dinner and a talk by an executive of that company.

American Engineering Council. Meeting May 24-25, at Washington, D. C. of Administrative Board.

American Water Works Association. Minnesota Section. Meeting with the Minnesota League of Municipalities, June 12-14, at Austin, Minn. Secretary, R. M. Finch, Wallace & Tiernan Company, 240 South Fourth St., Minneapolis, Minn.

TRADE CATALOGS

WHEELS—The Link-Belt Company, 910 So. Michigan Ave., Chicago, Ill., has just put out a 38-page book, No. 1167, showing detailed specifications of the 15,000 sprocket wheels it now carries in stock.

WATER-COOLED FURNACE—The Erie City Iron Works describe their Seymour Carbofax water-cooled furnace in a 7-page illustrated bulletin.

COMPRESSORS—The Sullivan Machinery Company, 400 No. Michigan Ave., Chicago, Ill., has published a new booklet, No. 83-L, entitled "Sullivan Angle Compound Air Compressors Direct Connected to Diesel Engines." There are many illustrations of Diesel engine compressor plants throughout the country for different kinds of service, mining and construction as well as industrial.

COUPLINGS — W. H. Nicholson & Company, 12 Oregon St., Wilkes-Barre, Pa., have issued Bulletin No. 329 on flexible couplings utilizing centrifugal force. The catalog is illustrated and eight pages in length.

WELDING—The A. O. Smith Corporation, of Milwaukee, Wis., has put out a 12-page bulletin, No. 501, in which the Smithwelding process is explained. There are interesting photographs of the welds, many times magnified, as well as details of the installations.

FUEL PRICES

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:

Bituminous (Net Tons)	Market Quoting	Price per Ton
Navy Standard	New York	$2.00 @ $2.55
Kanawha	Columbus	1.25 @ 1.45
Smokeless	Cincinnati	1.75 @ 2.00
Smokeless	Chicago	1.85 @ 2.25
S. E. Kentucky	Chicago	1.35 @ 1.65
Steam	Pittsburgh	1.40 @ 1.75
Gas Slack	Pittsburgh	1.00 @ 1.10
Big Seam	Birmingham	1.25 @ 1.50
Anthracite (Gross Tons)		
Buckwheat	New York	$2.60@$2.75
Barley	New York	1.35@ 1.50

FUEL OIL

New York—May 16, f.o.b. Bayonne, N. J., 28@34 deg., Baumé, industrial use, tank-car lots, 5c. per gal.; 36@40 deg., furnace, tank-car lots, 6c. per gal.

St. Louis—May 9, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1,3959 per bbl. or 42 gal.; 26@28 deg., $1.4459 per bbl.; 28@30 deg., $1.4959 per bbl.; 30@32 deg., $1.5459 per bbl.; 32@36 deg., gas oil, 4.276c. per gal.; 38@40 deg., distillate, 5.48c.

Pittsburgh—May 6, f.o.b. local refinery, 30@34 deg., fuel oil, 5c. per gal.; 36@40 deg., 5.5c. per gal.

Philadelphia—May 11, 13@19 deg., $1.05@$1.10 per bbl. or 42 gal.; 22 deg. plus, $1.47@$1.53 per bbl.; 23@27 deg., $2.10@$2.16 per bbl.

Cincinnati—May 6, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5c. per gal.; 26@30 deg., 5.25c. per gal.; 30@32 deg., 5.5c. per gal.

Chicago—May 11, tank-car lots, f.o.b., Oklahoma, freight to Chicago, 90c. per bbl. or 42 gal.; 22@26 deg., 60c. per bbl.; 26@30 deg., 80c. per bbl.; 30@32 deg., $1.00 per bbl.

Boston—May 13, tank-car lots, f.o.b. 12@14 deg. Baumé, 4.4c. per gal.; 28@32 deg., 5.55c. per gal.

Dallas—May 11, f.o.b. local refinery, 26@30 deg., $1.30 per bbl. or 42 gallons.

New Plant Construction

COMPILED BY THE McGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Ark., Mena — Southwestern Gas & Electric Co. awarded contract for remodeling and enlarging power plant including the installation of two 360 hp. Diesel engines, to L. E. Myers Construction Co., Allen Bldg., Dallas, Tex. Estimated cost $50,000.

Ark., Osceola—Bd. of Commissioners, Sewer Improvement Dist. 5, will receive bids until May 29, for the construction of a sewage disposal plant and pumping stations. T. H. Allen, 65 McCall St., Memphis, Tenn., is engineer.

Colo., Pueblo—S. A. Gerrard Co., 240 West 6th St., Cincinnati, O., R. A. Rollander, Colorado Bldg., Pueblo, Local Mgr., plans irrigation of 2,800 acres of land for agricultural development to include drilling water-wells, installing electrically driven pumps, etc. Estimated cost $1,000,000.

Conn., New Haven — Seamless Rubber Co., Hallock St., awarded contract for a 32 x 55 ft. power plant to Dwight Building Co., 67 Church St. Estimated cost $40,000.

Ill., Chicago—R. F. France & Co., 155 North Clark St., Archts., are receiving bids for the construction of a 10 story apartment building including central refrigeration plant at Sheridan Rd. and Galt St. Owners' name withheld.

Ind., Evansville — Bd. of Trustees, Waterworks Dept., will receive bids until May 23, for the construction of a booster pumping station.

Ia., Ottumwa — Iowa Southern Utilities Co., Centerville, is having preliminary plans prepared for addition to steam operated power plant here. Estimated cost $250,000.

Ky., Louisville — U. S. Engineers Office, is receiving bids for remodeling power house.

Louisiana, Alabama and Georgia—Southern Natural Gas Corp., Birmingham, Ala., awarded contract for the construction of a 1400 mi. natural gas pipe line from Monroe and Richland fields in Louisiana to Birmingham Ala. and Atlanta, Ga., to Ford, Bacon & Davis, Inc., 30 Broadway, N. Y. Plans include three compression stations, 5,000 hp. each to provide initial capacity of 100,000,000 cu.ft. of gas dialy. Estimated total cost approximately $35,000,000. G. L. Ohrstrom & Co., Inc., 14 Wall St., New York, N. Y., will finance the project.

Mass., North Reading — Dept. of Public Health, State House, will receive bids about June 1, for the construction of admitting and isolating building, also reconstruction of power house. Estimated cost $175,000. Stevens & Lee, 45 Newbury St., Boston, are architects.

Mass., Somerville (Boston P.O.)—First National Stores, 5 Middlesex St., awarded contract for the construction of a meat storehouse including refrigeration plant to Turner Construction 178 Tremont St., Boston. Estimated cost $1,500,000.

Mich., White Cloud—Consumers Power Co., Jackson, subsidiary of Commonwealth Power & Light Co., 14 Wall St., New York, N. Y., plans the construction of a hydro-electric power dam, 100 ft. long and 3,500 ft. wide on the Muskegon River to develop 40,000 hp. Plans include power plant, spillway three vertical a.-c. generators, etc. Private plans.

Mo., Jefferson City—Moerschel Products Co., awarded contract for conversion of steam operated manufacturing plant into electrically operated plant to L. Mundel & Son Inc., 461 8th Ave., New York.

Nebraska—Western States Utilities Co., H. Hord, Pres., Central City, awarded contract for the construction of electric power and ice plants at Creighton and Elgin to Betts-Blumer Engineering Co., Kearney. Estimated cost $125,000 and $45,000 respectively.

N. Y., Brooklyn—New York Times, 229 West 43rd St., New York, is having plans prepared for the construction of a 4 story, 150 x 200 ft., publishing plant between Pacific and Dean Sts. Estimated cost $1,000,000. A. Kahn, 1000 Marquette Bldg., Detroit, Mich., is architect.

N. Y., New York—H. and A. Polstein, 247 Park Ave., plan the construction of a 25 story hotel at 428-434 East 51st St. Estimated cost to exceed $1,000,000.

N. Y., Thiells—Dept. of Mental Hygiene, Albany, received lowest bid for addition to power plant for Letchworth village here from Ascher Engineering & Contracting Co., 1457 Broadway, New York. $100,000.

O., Brecksville (br. Cleveland) — Stations W.T.A.M. and W.E.A.R., c/o Cleveland Electric Illuminating Co., F. J. Ryan, V. Pres., Illuminating Bldg., Cleveland, plans the construction of a radio broadcasting station here. Estimated cost $200,000. Private plans.

Okla., Maud—City plans an election June 4 to vote on $75,000 bonds for waterworks improvements including new wells, pumping equipment, to Long & Co., Colcord Bldg., Oklahoma City, are engineers.

Okla., Stillwater—City awarded contract for a 28 x 41 and 51 x 52 ft. additions to power plant to L. J. Jardot, Stillwater. Estimated cost $30,000.

Pa., Philadelphia — Dept. of City Transit, City Hall Annex, will receive bids until May 31, for the construction of a power plant at Juniper and Pine Sts. Private plans.

Tex., Fort Worth — J. Jones & Associates, awarded contract for the construction of a department store to H. B. Friedman First National Bank Bldg. Estimated cost $2,000,000.

Tex., Groveton—City plans an election June 4, vote $25,000 bonds for waterworks improvements including pumping equipment, etc.

Tex., Schulenburg—Central Power & Light Co., Jones Ave., San Antonio, plans the construction of a power sub-station including complete equipment here. Estimated cost $50,000. Private plans.

Ont., Hamilton—W. L. Somerville, 2 Bloor St. W., Toronto, Archt., will receive bids until May 27, for the construction of a building, including boiler house, steam heating plant, etc. on Westdale St. here, for McMaster University. H. P. Whidden, 273 Bloor St. W., Toronto. Estimated cost $1,000,000.

Ont., Saulte Ste. Marie—Algoma Power Co., awarded contract for the construction of an electric sub-station to Lang & Ross, 527 Queen St. E. Estimated cost $150,000.

Que., Chapleau—Chapleau Electric Light & Power Co., awarded contract for the construction of a hydro-electric development to include dam, power house, two hydraulic units, 275 hp. capacity each, etc. to Dominion Construction Co., Sherbrooke St. W. Estimated cost $100,000.

Equipment Wanted

Boiler—City of Blackwell, Okla., is in the market for a 300 hp. stationary boiler for proposed waterworks.

Boilers, Stokers, Etc.—Iowa Southern Utilities Co., Ottumwa, Ia., three boilers, stokers, fans, four stacks, coal burner and conveyor, etc. for proposed improvements to power plant. Estimated cost $300,000.

Engine—City of Monroe City, Mo., will soon receive bids for the installation of a 240 hp. oil burning engine and auxiliary equipment for proposed addition to power plant. Estimated cost $30,000.

Engine and Generator—Treasury Dept., Office of Supervising Architect, Washington, D. C., will receive bids until June 12 for engine and generator for U. S. Marine Hospital, Fort Stanton, N. Mexico.

Generator and Motors—Central State Hospital, M. B. Helmer, Secy., Indianapolis, Ind., will receive bids until May 31 for an electric generator and motors for hospital.

Generators, etc. — Treasury Dept. Office of Supervising Architect, Washington, D. C., will receive bids until May 23, for furnishing and installing motor generator for U. S. Mint, Philadelphia. Former bids rejected.

Power Plant Equipment—B. & F. Prack, Pigot Bldg., Hamilton, Ont., Archts., are receiving bids for complete equipment for power plant in connection with factory building for W. Clark, Ltd., Harrow, Ont.

Pump, Motor, Etc.—James Irrigation Dist., A. F. Greene, Secy., San Joaquin, Calif., will receive bids until May 30 for furnishing and installing 11,250 g.p.m. screw pump direct connected to 3 ph., 60 cycle 440 v. motor for proposed waterworks.

Pump and Motor — City, E. Gardner, Clk., Merriman, Neb., will receive bids until May 23, for a 60 g.p.m. pump and motor, etc. for proposed waterworks improvements. Estimated cost $18,225.

Pumping Equipment—Atlantic Public Utilities Corp., 70 State St., Boston, Mass., electric or steam driven pumping equipment, etc. for proposed waterworks improvements.

Pumping Equipment—City of Brantford, Ont., will receive bids about June 1 for pumping equipment, etc. for proposed waterworks filatration plant. Estimated cost $500,000.

Pumps, Etc.—City of Villisca, Ia., one 2400 and two 250 g.p.m. horizontal centrifugal pumps, etc. for proposed water purification plant. Estimated cost $25,000.

Pumps, etc. — City of Hamilton, Ont., electrically operated pumps, etc. for proposed waterworks filtration plant. Estimated cost $1,000,000.

Industrial Projects

Ala., Gadsden — BLOOMING MILL — Gulf States Steel Co., W. Y. Coverdale, Pres., B.-M. Bldg., Birmingham, awarded contract for the construction of an electrically-driven blooming mill here, to United Engineering & Foundry Co., Farmers Bldg., Pittsburgh, Pa. Estimated cost $1,000,000.

Ala., Lanett — DYE PLANT and BOILER HOUSE — Lanett Bleachery & Dye Works, awarded contract for additions to plant including 5 story, 58 x 137 ft. warehouse, 20 x 47 ft. addition to boiler house, etc. to Batson-Cook Co., West Point, Ga.

Calif., Long Beach—ASSEMBLY PLANT and POWER HOUSE—Ford Motor Car Co., 1004 Marquette Bldg., Detroit, Mich., awarded contract for the construction of a 1 story, 315 x 930 ft. assembly plant, 100 x 400 ft. warehouse, 83 x 101 ft. power house, etc. here, to Clinton Construction Co., Stock Exchange Bldg., Los Angeles.

Conn., Hartford—WOODWORKING PLANT—L. F. Dettenborn Woodworking Co., Taylor St., had plans prepared for a 4 story, 40 x 200 ft. plant. Estimated cost $100,000. Private plans.

Ill., Bensenville—MOTOR FACTORY—Willis Motor Corp., First Ave. and Main St., Maywood, is having plans prepared for the construction of a 1 story, 60 x 1,600 ft. factory here. Estimated cost $1,200,000. G. E. Larson, 5154 North Clark St., Chicago, is architect.

Md., Baltimore—SOAP FACTORY AND POWER HOUSE—H. Manley, 5 East 53rd St., New York, N. Y., Archt., will receive bids until June 3 for the construction of a 3 story, 96 x 306 ft. factory including process building chipso building, kettle building, power plant and warehouse here for Procter & Gamble Mfg. Co., Gwynne Bldg., Cincinnati. Estimated cost $1,000,000.

Mass., Holyoke—PAPER MANUFACTURING PLANT—Chemical Paper Mfg. Co., Jackson St., is having plans prepared for the construction of a 2 and 3 story, 55 x 195 and 35 x 75 ft. paper manufacturing plant on ft. of Jackson St. Estimated cost $300,000. Private plans.

Mich., Detroit—BODY FACTORY—Freuhauf Trailer Co., 10940 Harper Ave., will soon award contract for the construction of a 1 story factory. Estimated cost $50,000. A. Kahn, 1000 Marquette Bldg., is architect. Electric motors and equipment for assembly of truck trailer bodies will be required.

Mich., Detroit—BRASS ACCESSORY FACTORY—Clayton Lambert Co., French Rd., awarded contract for a 1 story, 100 x 100 ft. factory for the manufacture of torches and automobile accessories to J. A. Utley, 700 Harper Ave. Estimated cost $40,000.

Mo., Bridgeton — AIRPLANE FACTORY ADDITION — Curtiss-Robertson Airplane Mfg. Co., c/o W. R. Robertson, is having preliminary plans prepared for a 1 and 2 story addition to plant at Lambert-St. Louis flying field. Estimated cost $300,000.

O., Canton—TUBE MILL—Timken Roller Bearing Co., Dueber Ave., plans the construction of a 1 story tube mill on Gambrinus St. Estimated cost $200,000. Private plans.

O., Cleveland—STEEL PARTITION FACTORY—E. F. Hauserman Co., E. Hauserman, Pres., 6800 Grant Ave., awarded contract for a 2 story, 80 x 270 ft. factory to Aronberg-Fried Co., Public Sq. Estimated cost $100,000.

O., Cleveland—CHEMICAL FACTORY—McGean Chemical Co., 1822 B. F. Keith Bldg., is receiving bids for the construction of a group of buildings, 1 and 2 story for chemical factory at Clark Ave. Estimated cost $150,000. Christian, Schwarzenberg & Gaede Co., 1836 Euclid Ave., are architects.

Wash., Seattle—AUTOMOBILE BODY PLANT—Fisher Body Co., E. F. Fisher, General Motors Bldg., Detroit, Mich., awarded contract for the first unit of plant here, to Austin Co., Dexter Horton Bldg., Seattle. Estimated cost $500,000.

B. C. Vancouver—AIRPLANE FACTORY—Boeing Aircraft Ltd. of Canada, Hoffar-Beeching Shipyards, will build an airplane factory on Georgia St. W. Estimated cost $100,000. Work will probably be done by day labor.

Ont., Ojibway—STEEL and FENCING PLANT—Canadian Steel Corp., plans the construction of a 1 story factory for the manufacture of reinforcing steel and fencing. Estimated cost $200,000. Private plans.